SASKATCHEWAN

STATE OF THE ENVIRONMENT REPORT

91-05247/

June, 1991

Dear Reader:

Environmental protection is more than a conversation topic. It has become a concern of daily life.

Saskatchewan people now expect comprehensive information on which they can base their decisions about personal actions and provincial policies relating to the environment.

Last year the Legislative Assembly passed The State of the Environment Report Act, guaranteeing citizens an annual account of Saskatchewan's environmental health. The document you are reading is Saskatchewan's first State of the Environment Report.

Readers will find two themes recurring in this report.

- Saskatchewan's environmental concerns are primarily rural and resource based due to the predominance of agriculture and primary industry. In other parts of the country, urban and industrial concerns are common.
- Our challenge is mainly to protect an environment that is still relatively clean, rather than doing the major clean-ups so common in some of the world's smokestack industrial centres.

These themes will guide our priorities in the years ahead, helping us determine where to direct our attention and how to invest our environmental resources.

Twelve government agencies cooperated to prepare this first report. We know our prototype will have room for improvement, and we expect subsequent editions to reflect those changes.

For that reason, I have appointed an independent public advisory committee to assess the report and recommend improvements for future editions.

I would also ask two things of you.

- Please take time to examine the report and relate it to your own life and responsibilities as a Saskatchewan resident.
- Then, please give me your ideas on how we can develop and improve future reports. A 'Comments' page at the end of the report invites your ideas and suggestions; we welcome your opinions.

Together, working in partnerships involving individuals, organizations, industries, municipalities and the provincial government, we can protect our natural advantages and enhance our environment.

The task will involve all of us, because a healthy environment is everyone's responsibility.

Sincerely

Grant Hodgins
Minister

PREFACE

In today's world, there are often more opinions than facts, especially about issues in the public eye. People need a convenient and reliable source for all the facts, and the opportunity to draw their own conclusions from objective information.

That is what readers can expect of Saskatchewan's first State of the Environment Report. It contains much information with a minimum of interpretation. It should help readers do three things:

- identify established or developing environmental trends;
- identify potential issues or problems; and,
- compare Saskatchewan's performance with others.

Some may find the information useful for making policy and program decisions, and helpful as a measuring stick to evaluate them. Others will discover information that explains a current or coming regulation, and the part it plays in the broad umbrella of environmental protection.

Conclusions readers draw from this report can be updated annually as State of the Environment Reports will be published each year. Reports may change from time to time to accommodate users' needs, and to fairly reflect current and developing environmental issues.

Welcome, reader. Please read the report with an inquiring eye, to better understand the state of Saskatchewan's environment. Read it with a critical eye, so you can help find ways to enhance future reports.

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INTRO

More than ever before, people are talking about the environment. Global warming and acid rain, news of major spills and tire fires, and increased public awareness drive home the fact that our environment is fragile and finite. Our daily activity affects all aspects of our environment. From morning shower to late night news, we use either renewable or non-renewable resources. How we use these resources determines what remains available for future generations.

How do our actions affect Saskatchewan's environment? The Saskatchewan State of the Environment Report is a major step in finding the answer.

OBJECTIVES

The Saskatchewan State of the Environment Report has five objectives:

- to identify resource use and management issues;
- to identify trends in resource use;
- to inform Saskatchewan people about environmental issues;
- to give decision makers a tool to gauge how their policies and programs affect the environment; and,
- to identify environmental indicators which need to be developed.

FORMAT

The report's first eight sections deal with the environmental and economic effect of using renewable and non-renewable natural resources (air, water, land [soil], wildlife, fisheries, forestry, oil, gas and minerals). The final four sections show how our man-made components (built or urban environment, historical resources, power and waste generation) affect the natural environment. Every section deals with specific environmental issues. Some sections feature *Focus Issues*, discussions of special interest.

Where possible, data illustrate the current state of affairs. Some data may serve as *environmental indicators*: values that indicate or imply a level of environmental quality. Some everyday examples include interest and inflation rates, which indicate a country's economic health; major North American cities rate their air quality against an air quality index; the Richter Scale indicates an earthquake's relative intensity and potential for life and property damage.

Indicators of environmental quality and sustainability for most resources have yet to be developed. Where environmental indicators are unavailable, this report presents raw data and statistics. As state of the environment reporting develops throughout Canada, existing indicators will be refined and new indicators created.

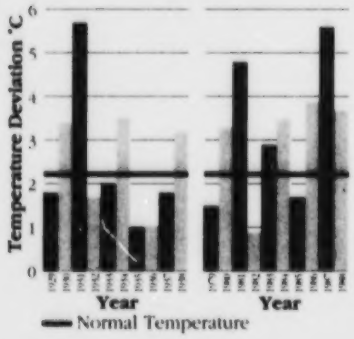
Where available, the report presents information in its historical context. In other cases, the report presents the most recently available information. In all cases, data presented for the most recent year will be the baseline for future comparisons.

THE AIR A

IN THIS SECTION...

- Saskatchewan's climate has natural heat and drought cycles; the 1980s were hotter and drier than the 1930s
- Many scientists believe fossil fuel burning contributes to the perceived global warming trend
- Air pollution comes from man-made and natural sources
- Saskatchewan's air quality standards equal the highest national standard
- Industrial emissions are regulated by permit under The Clean Air Act

Figure 1: Temperature Deviations From Normal, 1930s and 1980s, Regina



REGIONAL CLIMATE

Saskatchewan's climate is semi-arid with hot, dry summers and long, cold winters. Though commonly short of moisture, regions vary, even in the same year. One area can experience drought while another has normal or above average moisture conditions. Our main soil moisture sources are spring and summer rains.

The prairies had below normal moisture conditions in 1989 and 1990, similar to several dry periods in the last century. Most notable was the Dirty Thirties. However, 1986 to 1988 surpassed the 1930s for low precipitation and record temperatures.

Figures 1, 2, 3 and 4 show deviations from normal temperature and precipitation at Regina and Saskatoon during the 1930s and 1980s. The 1980s drought had higher temperatures and similar or less precipitation. Higher temperatures increased soil moisture evaporation, spreading drought conditions wider than in the 1930s.

CLIMATE CHANGE

Many leading scientists believe the trend is to *global warming*: long term climatic change with steadily increasing temperatures in the earth's lower atmosphere. They suggest that in the next 50 years, significant temperature increases will occur, perhaps more than during the last 10,000 years.

While global warming is not an absolute certainty, scientific evidence points this way. In Saskatchewan, recurring regional droughts and the high temperatures of the 1980s seem to validate the scientists' assertions.

This potential warming trend is likely caused by more *greenhouse gases* in the atmosphere, primarily carbon dioxide, nitrogen oxides, methane and chlorofluorocarbons (CFCs). Except for CFCs, most of the gases come from producing and using fossil fuels. Global warming is discussed more fully in the **Power Generation** section.

Figure 2: Temperature Deviations From Normal, 1930s and 1980s, Saskatoon

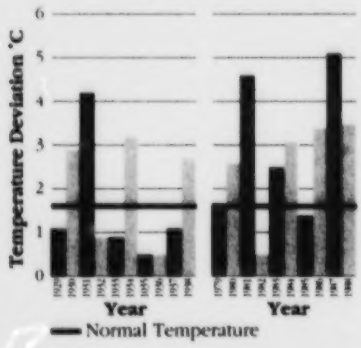


Figure 3: Precipitation Deviations From Normal, 1930s and 1980s, Regina

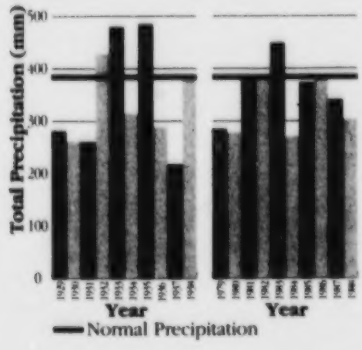
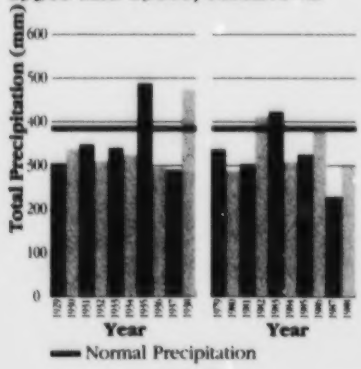


Figure 4: Precipitation Deviations From Normal, 1930s and 1980s, Saskatoon



AIR QUALITY

The air around us is never completely pure. It always contains some natural contamination: wind-blown dust, forest-fire smoke, ocean-salt particles or gases from volcanic eruptions. For millions of years, natural forces kept the atmosphere fairly clean. Wind, rain and snow redistributed airborne matter to earth's surface. Plants absorbed carbon dioxide and released fresh oxygen. Our self-regulating atmosphere maintained an equilibrium without accumulating life threatening contaminants.

Population growth and the industrial era burden the atmosphere. Wastes from fuel consumption, resource recovery, manufacturing, transportation, agricultural operations and other activities, are discharged into the atmosphere at tremendous rates. Sometimes, air pollution emissions exceed the atmosphere's natural ability to assimilate and disperse them.

Table 1:
Major Air Pollutants

Pollutant	Description
Sulphur Dioxide	• released by burning fuels containing sulphur or processing sulphur-bearing ores • irritates respiratory systems, causes vegetation damage, corrodes many materials
Nitrogen Oxides	• a byproduct of fuel consumption • may cause respiratory disease, damage vegetation, reduce visibility, contribute to acid rain
Carbon Monoxide	• formed by incomplete combustion of fossil fuels • decreases the blood's oxygen-carrying capacity causing dizziness, headaches, and impairing mental processes
Hydrocarbons	• a term for a large number of volatile organic compounds released during processing, chemical manufacturing, and storage tank losses • may cause odour problems and vegetation damage • in combination with nitrogen oxides, they form secondary pollutants such as ozone
Particulate Matter	• solid particles and aerosols released from industrial operations, agriculture, fuel combustion • can contribute to respiratory disease, harm vegetation and soils, and corrode some materials
Ozone	• the most common secondary pollutant • formed when hydrocarbons and nitrogen oxides react in the presence of sunlight • may cause respiratory system irritation and vegetation damage

• Pollution and Pollutants

Air pollution is defined as release of enough contaminants into surrounding air to adversely affect air quality. Air pollution endangers individual health, safety and well-being, injures plant and animal life, and damages property. Pollution can affect small populations in limited areas, but can also become a large regional, even global, problem.

Substances (except carbon dioxide and water vapour) emitted directly from their sources into the atmosphere are called *primary pollutants*. In the air, chemical reactions may convert primary pollutants into *secondary pollutants*. Complex mixtures of primary and secondary pollutants create *smog*: an irritating, visibility-reducing haze. In many cases, secondary pollutants produce more serious effects than the original primary pollutants.

Man-made pollutants in Saskatchewan are sulphur dioxide, nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter and ozone. These materials are measured regularly, and are described in Table 1.

• Air Pollution Index

Air pollution monitoring results are reduced to an index to indicate air quality at a monitoring location. Indices can be maximum desirable (good), maximum acceptable (fair), and maximum tolerable (poor) (Table 2). The index is calculated by tabulating the relative risk of the top three pollutant concentrations. The highest of the three risk values indicates the overall air quality.

Saskatchewan adopted the national air quality objectives as the provincial standard in 1976. This measure has helped ensure good air quality. The objectives also promote control technology development and application.

Table 2:
National Air Quality Objectives[1]

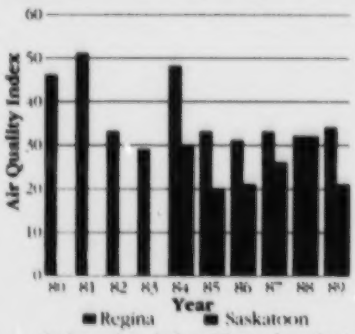
Maximum desirable (good)
- the long term goal for air quality

Maximum acceptable (fair)
- denotes adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being

Maximum tolerable (poor)
- denotes a concentration of an air contaminant that requires abatement without delay to avoid further deterioration to an airquality endangering the prevailing Canadian lifestyle or, ultimately, to an air quality posing a substantial risk to public health

Particulate matter (primarily dust from agricultural operations), ozone and carbon monoxide contribute the most to Regina and Saskatoon's air pollution indices. Figure 5 shows the air pollution indices for those cities.

Figure 5:
Air Quality Index for Regina and Saskatoon, 1980-1989



Index values below 25 are described as good, between 25 and 50 is fair and above 50 is poor.

Data for Saskatoon unavailable prior to 1984

• Air Quality - Cities

The Saskatchewan government monitors air quality in Regina and Saskatoon as part of the National Air Pollution Surveillance Network. The network is a joint federal/provincial cost shared initiative. It monitors long term trends in urban air pollution concentrations and indicates how successful emission control measures are. The province does not monitor other urban centres or rural areas.

Since measured air quality is pertinent only to the location where it was measured, air quality data should not be extrapolated. An area a few hundred metres away may have a totally different air quality level.

• Air Quality - Homes

Uranium 238 occurs in small concentrations in most soils. Its natural decay produces radon, a radioactive gas that may accumulate in some homes. Radon decay products (also known as *radon progeny or daughter products*) are solid particles that may be trapped in the human respiratory system. Prolonged exposure to high levels of radon may increase the risk of developing lung cancer.

The government's Radon in Homes Program advises people how to test their homes for radon, and provides information about health risks, interpreting test results and reducing radon levels. Government received 120 inquiries about radon in 1989.

• Air Quality - Industry

To maintain national air quality objectives, the government regulates stationary air pollutant sources with a permit system. Every industrial, commercial, manufacturing or public facility with *significant emissions* (potential to deteriorate airquality), must obtain a permit to operate in accordance with The Clean Air Act.

Conditions attached to permits can contain monitoring, operating and reporting requirements. Operating requirements may specify the use of special equipment to control emissions, and can also limit the emission amount or concentration.

In 1989, 11 new operating permits were issued, bringing the province's operating permit total to approximately 400.

1 Environment Canada. 1983. National Air Pollution Surveillance: Annual Summary.

Of the permit-holding industries, generally all maintain provincial air quality standards. If an industry violates the standards or the public complains about emissions, the government may extend emission monitoring, impose more stringent permit conditions or an emission control order, or take legal action.

DOWN THE ROAD...

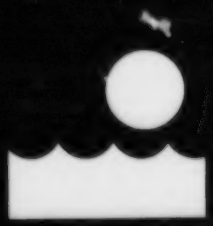
- Develop mechanisms to better monitor pollution in rural Saskatchewan
- Expand air pollution monitoring to include major Saskatchewan cities
- Have more than one air quality monitoring station per centre

FOCUS ISSUE 1:

The Ozone Depleting Substances Control Act

The Ozone Depleting Substances Control Act was tabled in Saskatchewan's Legislature in 1990, and became effective January 1, 1991. The Act controls the manufacture, sale, collection, storage, recycling, and disposal of substances that may contribute to ozone layer depletion. Substances such as CFCs (chlorofluorocarbons), are targeted.

The Act bans the use of CFCs in non-essential applications and requires that more harmful CFCs be phased out and replaced with more environmentally friendly products over the next eight years. The phase-out schedule is consistent with the national program.



SOURCES

IN THIS SECTION...

- Municipalities must periodically sample their water supply for laboratory evaluation against municipal drinking water quality objectives
- Municipal sewage effluent discharge is monitored spring and fall to evaluate compliance with Water Pollution Control and Waterworks Regulations
- Industrial effluents are regulated through operating permits; several industries operate under zero-discharge conditions
- Province-wide surface water quality monitoring provides data for trend or problem evaluation, and environmental impact assessment
- Trans-boundary agreements govern water sharing with adjacent jurisdictions, and allocation permits control in-province rights to water use

WATER QUALITY

Municipal Water Quality

Most municipal water systems in Saskatchewan depend on groundwater. Its quality is usually consistent and fairly highly mineralized. Surface water supplies on the other hand, usually have lower mineral concentrations but are prone to seasonal quality changes affecting clarity, colour, taste and odour. Whatever the source, local water utilities must treat and provide safe drinking water to consumers.

Water quality is measured against municipal drinking water quality objectives which provide bench marks for specific quality parameters. The objectives help municipalities produce palatable, aesthetically pleasing and safe drinking water. The objectives identify bacteria, general chemical, physical, health and toxicity categories to interpret and evaluate water quality.

Saskatchewan had 534 municipal waterworks in 1989. Communities must regularly test representative water samples to ensure consumers have safe, high quality, potable water.

- **Bacteriological Performance and Disinfection**

Municipalities must regularly test water supplies for coliform bacteria. None of these indicator organisms should be detected if waterworks are properly operated. Of about 10.3 thousand samples analyzed in 1989, 236 or 2%, contained coliform bacteria. That number should be reduced.

In 1989, many communities submitted less than the required number of water samples for bacteriological testing (15.8 thousand samples required, 10.3 thousand submitted). Sample requirements are reviewed annually with communities, stressing the importance of regular bacteriological testing.

Because water free of disease-causing bacteria is important for public health, provincial regulations require all municipalities to disinfect water supplies with chlorine before distribution to consumers. Only 18 communities use unchlorinated water (1989), down from 60 communities in 1984.

- **Trihalomethanes**

Trihalomethanes (THMs) are a health concern. THM concentrations consistently exceeding the objectives are suspected of increasing consumers' risk of developing cancer. Trihalomethane compounds can form when chlorine reacts with organic materials, usually found in surface water supplies. The maximum acceptable level of THM, according to drinking water quality objectives, is 350 micrograms per litre (ug/L). Municipalities are encouraged to maintain THM levels below 100 ug/L whenever possible.

In 1989, 371 water samples from 111 communities were tested. THM levels between 0 and 100 ug/L showed in 154 samples; 180 had THM levels between 100 ug/L and 350 ug/L; and 37 samples (from three communities) exceeded 350 ug/L.

- **Nitrate**

Nitrate is a health related parameter. High nitrate levels in water reduce the blood's oxygen-carrying capacity, to which infants are particularly sensitive. High concentrations can indicate water contamination from fertilizers, human and/or animal wastes. The maximum acceptable concentration is 40 milligrams per litre (mg/L).

The government monitors nitrate levels closely, particularly in communities using shallow groundwater sources for their municipal water supply. Although the natural environment normally has low nitrate levels, 5 Saskatchewan communities have nitrate levels above 40mg/L in their water supply (Figure 6). The communities have advised their consumers.

- **Turbidity**

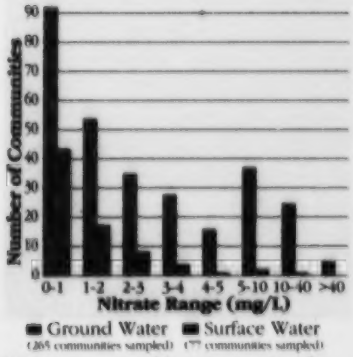
Turbidity is a measure of suspended material in water. High turbidity may affect both bacteriological quality and effective water disinfection. Sophisticated treatment is required to removed suspended materials from water.

The municipal drinking water quality objective for turbidity is 5 units. Municipalities are encouraged to maintain the lowest possible turbidity, preferably less than 1 unit. Virtually all groundwater-dependent communities meet the 5 turbidity unit objective and most maintain turbidity below 1 unit (Figure 7). Most surface water communities also meet the 5 turbidity unit objective.

- **Sodium**

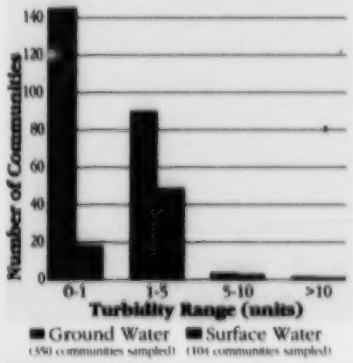
All natural waters contain sodium; groundwater usually contains more than surface water. People on salt-restricted diets may be affected by drinking water with too much sodium. Water in 58 communities has levels exceeding the 300 mg/L maximum desirable objective (Figure 8). Periodically these municipalities are reminded to inform consumers about sodium in their water supply.

Figure 6:
Comparison of Nitrate Values, Ground and Surface Water Supplies, 1988-1989



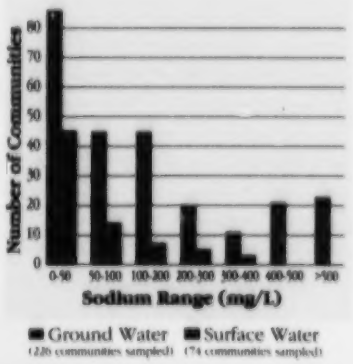
Maximum acceptable concentration for Nitrate is 40 mg/L.

Figure 7:
Comparison of Turbidity Values, Ground and Surface Water Supplies, 1988-1989



Maximum drinking water quality objective for Turbidity is 5 units.

Figure 8:
Comparison of Sodium Values, Ground and Surface Water Supplies, 1988-1989



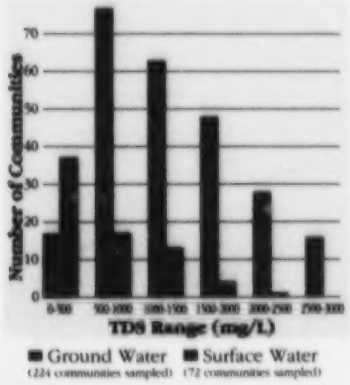
Maximum desirable objective for Sodium is 300 mg/L.

- **Total Dissolved Solids**

The Total Dissolved Solids (TDS) parameter measures how much dissolved material water contains. Groundwater often has a high mineral content, since most municipal wells tap deep aquifers. In contrast, most surface water sources contain much lower TDS levels.

Figure 9 compares TDS values from ground and surface water supplies. Over one-third of groundwater supplies reported TDS values exceeding the 1,500 mg/L maximum desirable objective. Only about 7% of surface water supplies exceeded the objective level.

Figure 9:
Comparison of Total Dissolved Solids Values, Ground and Surface Water Supplies, 1988-1989



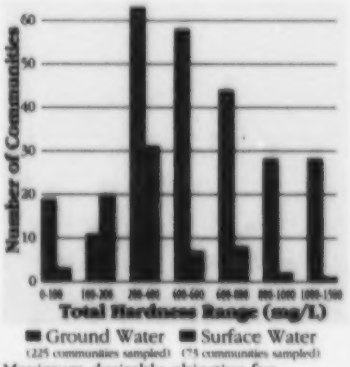
Maximum desirable objective for TDS is 1,500 mg/L.

- **Total Hardness**

Most Saskatchewan municipalities have hard water. *Hardness* refers to water's capacity to produce lather from soap. Dissolved calcium and magnesium dictate water's hardness. While hard water is very common, most Saskatchewan communities' water is below the maximum desirable objective of 800 mg/L.

Typically, dissolved minerals make groundwater supplies harder than surface water sources. Water hardness values exceed 800 mg/L in 59 communities (Figure 10). In these communities, the median hardness is 1,016 mg/L. Consumers can soften incoming water supplies for domestic purposes.

Figure 10:
Comparison of Total Hardness Values, Ground and Surface Water Supplies, 1988-1989



Maximum desirable objective for Total Hardness is 800 mg/L.

Sewage Treatment

Sewage treatment facilities are regulated under the Water Pollution Control and Waterworks Regulations. Permits are issued for discharges from these facilities.

In Saskatchewan, 597 municipal, private and government (non-industrial) sewage treatment facilities operate under government jurisdiction. Of the 518 treating municipal sewage, 495 use facultative lagoons (usually a two cell earthen berm, open reservoir configuration). The remaining 23 municipalities use other mechanical or mechanically-assisted treatment technologies.

Fifty municipalities discharge their treated sewage effluent indirectly to the environment, reducing impact on water quality. Their disposal methods may include effluent irrigation, wet land disposal (Ducks Unlimited projects) and zero-discharge evaporation facilities.

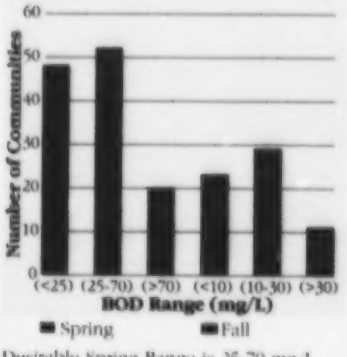
Figures 11, 12 and 13 compare treated sewage effluent quality for spring and fall, 1989. Samples were measured against three key parameters from government guidelines for expected effluent quality.

Figure 11 shows how many communities met or exceeded the spring and fall upper range effluent quality guideline for biochemical oxygen demand. Of the 63 lagoon discharges, 51 met the 30 mg/L fall guideline; 99 of the 120 lagoons met the spring guideline of 70 mg/L.

Figure 12 illustrates compliance with the spring and fall upper range effluent quality guideline for total suspended solids. Of the 161 lagoon discharges tested, 133 met the spring guideline of 60 mg/L; 95 of the 137 lagoon discharges tested met the fall guideline of 40 mg/L.

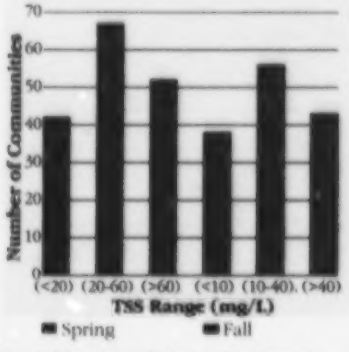
Figure 13 shows how many communities met or exceeded spring and fall upper range effluent quality guidelines for total coliform bacteria. Of the 146 analyzed spring lagoon discharges, 128 met the spring guideline of 200 thousand coliform bacteria; 114 of 123 fall discharges met the 20 thousand coliform bacteria fall guideline.

Figure 11:
Biochemical Oxygen Demand of Facultative Lagoon Discharges, 1989



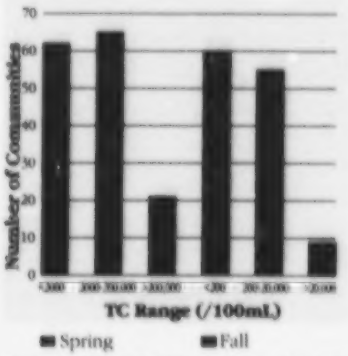
Desirable Spring Range is 25-70 mg/L
Desirable Fall Range is 10-30 mg/L

Figure 12:
Total Suspended Solids of Facultative Lagoon Discharges, 1989



Desirable Spring Range is 20-60 mg/L
Desirable Fall Range is 10-40 mg/L

Figure 13:
Total Coliforms of Facultative Lagoon Discharges, 1989



Desirable Spring Range is 2,000 - 200,000 coliforms/100mL
Desirable Fall Range is 200 - 20,000 coliforms/100mL

Industrial Effluent Treatment

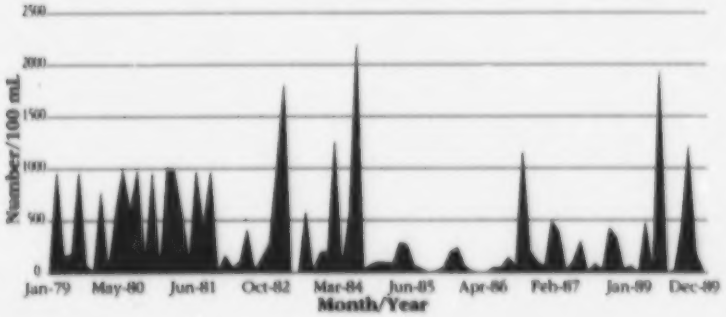
Industrial effluent works, except mining operations, are regulated under The Environmental Management and Protection Act and the Water Pollution Control and Waterworks Regulations. Industrial operations require a permit to construct, install, alter, expand or operate any industrial effluent work.

Table 3 identifies industries issued permits under these regulations. The table shows how many industries use zero-discharge technology and how many must meet effluent discharge limits.

Table 3:
Permits Issued for Industrial Operations, 1989

Industry Type	Total Permitted Facilities	Permits for Zero-Discharge	Permits for Discharge Limits	Percent Compliance
Thermal Electrical Generation	4	2	None Established	-
Wood Product	1	-	1	98
Petroleum	2	-	1	100
Chemical	3	-	2	98
Fish Operations	2	1	None Established	-
Miscellaneous	5	4	1	100
Total	17	7	5	

Figure 14:
Fecal Coliform Densities, South Saskatchewan River at Clarkboro Ferry (West Side)



2 Storm water releases only.

SURFACE WATER QUALITY MONITORING

Surface water quality monitoring networks are operated on Saskatchewan's major rivers and lakes to:

- determine seasonal water quality variations and measure long term water quality changes or trends;
- establish baseline water quality conditions for environmental impact assessment;
- assess effects of waste discharges, spills, etc. arising within or outside Saskatchewan;
- determine the water's suitability for specific uses; and,
- provide data for establishing and reviewing surface water quality objectives.

Municipalities and industries discharging treated waste water into surface water also monitor water quality to help assess potential environmental effects.

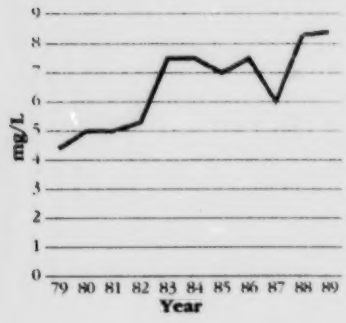
All water quality monitoring data is stored in ESQUADAT (a government database) and checked against Saskatchewan's water quality objectives. The system helps to identify problems early, and permits design of special studies to solve the problems.

For example, coliform bacteria were detected at Clarkboro Ferry (South Saskatchewan River downstream of Saskatoon). Many samples exceeded the water quality objective for fecal coliform bacteria, 200 counts/100ml, a level safe for water recreation (Figure 14). The

City of Saskatoon and the provincial government jointly studied the situation and recommended improvements to Saskatoon's sewage treatment plant.

ESQUADAT data also help examine long term water quality trends. Figure 15 shows a statistical trend analysis of chloride concentrations in the South Saskatchewan River at Outlook. Data from 1983 to 1985 show a statistically significant increase in chloride at Outlook, though not large enough to affect downstream water uses. Further investigation showed that high evaporation and low inflows to Lake Diefenbaker during the drought caused the chloride increase.

Figure 15:
Chloride Concentration, South Saskatchewan River at Outlook, Mean Annual Concentration



During 1988 to 1990, government conducted special water quality investigations. The studies permitted clearer understanding of the processes affecting surface water quality and identified environmental protection measures which needed improvement (Table 4).

Table 4:
Water Quality Studies Undertaken

Location	Purpose
Saskatchewan River near Nipawin	• assess effects of the Nipawin hydroelectric project and effects of discharge from the Town of Nipawin and CSP Food
South Saskatchewan River near Saskatoon	• delineate effluent-mixing zones for the City of Saskatoon, Saskatoon Chemicals Limited and Azko Chemicals
North Saskatchewan River near North Battleford	• delineate mixing zones for the Town of Battleford and City of North Battleford treated sewage discharge
Qu'Appelle River	• evaluate biological monitoring techniques
Lake Diefenbaker	• evaluate lake trophic status and development of water quality objectives to prevent eutrophication

Groundwater

Agricultural chemicals (pesticides and fertilizers) can be major sources of potential groundwater contamination. Excessive use or improperly stored pesticides can contaminate groundwater, while excessive fertilizer use can increase groundwater nitrate levels. European countries (heavy fertilizer users) find this pollution source a major problem.

While Saskatchewan lacks a comprehensive groundwater monitoring system, nitrate and agricultural chemical groundwater contamination is not a major concern. Potash mining, however, has the potential to contaminate groundwater given its wide range, long time frame and waste volume. Mining is discussed more fully in the **Non-Renewable Resources** section.

WATER ALLOCATION

Surface Water

Water allocation (designation of water for domestic, municipal, industrial, irrigation and other uses) is regulated by The Water Corporation Act. Before water licences are granted, supply studies, assessing water availability and effects on other licensed users, are completed. Licensed users are granted approval for the lifetime of the waterworks.

- **Water Use**

Water use in Saskatchewan varies with location. Table 5 illustrates variations between users' water intake and consumption by river basins. Water that is not consumed is returned to the river basin.

Table 5:
Summary of Saskatchewan Water Intake (I) and Consumption (C) by Major Users and River Basins, 1985, (000 cubic decameters, or dam³)

River Basin	Agricultural		Mining		Industrial Commercial		Power Generation		Residential and Public		Total		% of Provincial Total	
	I	C	I	C	I	C	I	C	I	C	I	C	I	C
Souris	11.7	11.7	31.2	31.2	2.1	0.1	501.5	7.5	6.9	3.0	553.4	53.5	30.8	9.2
Missouri	65.6	65.6	0.9	0.9	0.2	T[3]	542.7	6.2	1.1	0.7	610.6	73.4	34.0	12.6
Cypress Hills	29.9	29.9	12.8	12.8	0.3	T	0	0	1.0	0.5	44.0	43.2	2.4	7.4
Old Wives	43.3	53.3	3.0	3.0	0.7	T	0	0	2.6	1.2	59.6	57.5	3.3	9.9
Qu'Appelle	54.9	54.9	8.1	8.1	15.5	1.1	0	0	40.2	15.0	118.6	80.0	6.6	13.6
South Sask.	174.1	174.1	8.7	8.7	11.3	0.6	74.2	0.3	31.7	11.5	300.0	195.2	17.0	33.5
North Sask.	34.1	34.1	11.8	11.8	5.3	0.3	0	0	17.0	7.0	68.2	43.2	3.8	9.1
Saskatchewan	3.4	3.4	0	0	1.5	0.1	0	0	5.6	2.6	10.5	6.1	0.6	1.0
Assiniboine	4.3	4.3	0.7	0.7	2.2	0.1	0	0	6.6	2.7	13.8	7.7	0.8	1.3
L.Winnipegosis	4.2	4.2	0	0	0.4	T	0	0	2.1	1.3	6.7	5.5	0.4	0.9
Northern Four	2.1	2.1	4.0	4.0	1.1	0.1	0	0	4.2	2.0	11.4	8.2	0.6	1.4
Total	437.5	437.5	81.1	81.1	40.7	2.4	1,118.4	14.1	119.1	47.4	1,796.8	582.5		
% of Total	24.3	75.1	4.5	13.9	2.3	0.4	62.2	2.4	6.6	8.1				

- **Water Apportionment Agreements**

Saskatchewan has agreements on water sharing with neighbouring provinces and states. Generally, Saskatchewan is entitled to half a river or stream's natural flow entering the province; half must be left for downstream jurisdictions. Since 1979, recorded flow from Saskatchewan has averaged about twice Manitoba's annual entitlement. Similarly, Saskatchewan has received more than half its entitlement from Alberta.

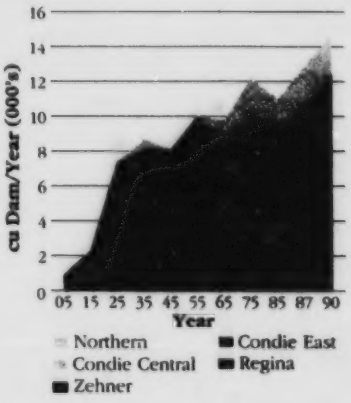
Groundwater

About 454 thousand residents or 45% of the population depends on groundwater from private wells. About 76%, or 386 communities, use a groundwater supply. Saskatchewan has approximately 50 thousand wells.

Groundwater Use

Per capita water use is increasing. Figure 17 illustrates this trend. Today, a person living in a community with a municipal water system uses close to 400 L of water per day as compared to 358 L in 1985. As groundwater use increases, it becomes more important for provincial water managers to monitor demands on both groundwater aquifers and surface water supplies.

Figure 17:
Total Historic Production from the Regina Aquifer System



3 T = Trace

The Regina Aquifer System

An aquifer management plan is being developed for the Regina Aquifer, one of the most heavily used in Saskatchewan. While the aquifer is being studied, no new water allocations are being made. If monitoring shows declining water levels, allocation cuts may be considered. Table 6 identifies rates of water use from the Regina Aquifer system.

Effects of Drought

Much of Saskatchewan's rural population uses shallow wells or dugouts for their water supply. Drought can severely affect water tables supplying those wells and dugouts, thereby increasing domestic water supply costs. In the 1988-89 drought, governments granted $31 million to drill wells, dig dugouts or haul water for some 25 thousand residents.

Table 6:
Summary of Water Use from the Regina Aquifer System[4]

Aquifer	User	Volume Pumped/ Year (dam^3)	% Pumpage for Aquifer	% Total Pumpage for Entire Aquifer System
Regina	City of Regina	3,135	56.1	21.5
	Industrial	2,292	41.0	15.7
	Irrigation	95	1.7	0.7
	R.M. of Sherwood	65	1.2	0.4
	Total	5,587	100.0	38.3
Condie Central	R.M. of Sherwood	21	100.0	0.1
Condie East	City of Regina	352	33.9	2.4
	Local Golf Courses	186	18.0	1.3
	Pilot Butte	255	24.6	1.7
	White City	125	12.0	0.9
	R.M. of Edenwold	87	8.4	0.6
	Industrial	32	3.1	0.2
	Total	1,037	100.0	7.1
Zehner	City of Regina	5,170	91.0	35.4
	Balgonie	225	4.0	1.5
	R.M. of Edenwold	301	5.0	2.1
	Total	5,696	100.0	39.0
Northern	City of Regina	2,255	100.0	15.5
Totals for Aquifer System		14,596		100

4 All figures are based on 1990 pumpages.

FOCUS ISSUE 2

Mercury in Saskatchewan Fish

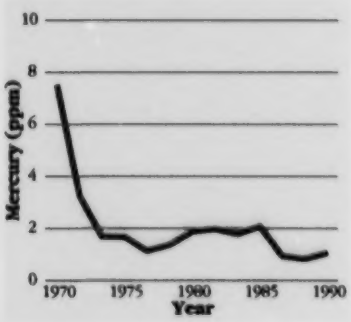
Fish in major Saskatchewan lakes and rivers have been monitored for mercury since 1969. The provincial Contaminants-in-Fish Committee monitors recreational waters, while Canada Fisheries and Oceans tests fish caught for commercial sale.

The Contaminants-in-Fish Committee includes representatives from three provincial government departments who collect fish samples for analysis. After comparing results to data from Canada Fisheries and Oceans, the committee makes recommendations about consumption.

In the past, mercury was released into the environment through such industries as a chlor-alkali plant in Saskatoon, and through mercury-based seed grain fungus control operations. These sources have been virtually eliminated. As a result, mercury concentrations in fish are gradually declining.

Figure 16 shows the declining mercury level trend in South Saskatchewan River fish below Saskatoon. At one time, mercury levels in fish were so high there that fish consumption was not recommended. The levels have declined enough that limited consumption is now possible.

Figure 16:
Mercury Levels In Walleye, South Saskatchewan River Below Saskatoon, 1970-1990



DOWN THE ROAD...

- Develop an overall water quality index
- Develop a comprehensive groundwater monitoring system

OURCES

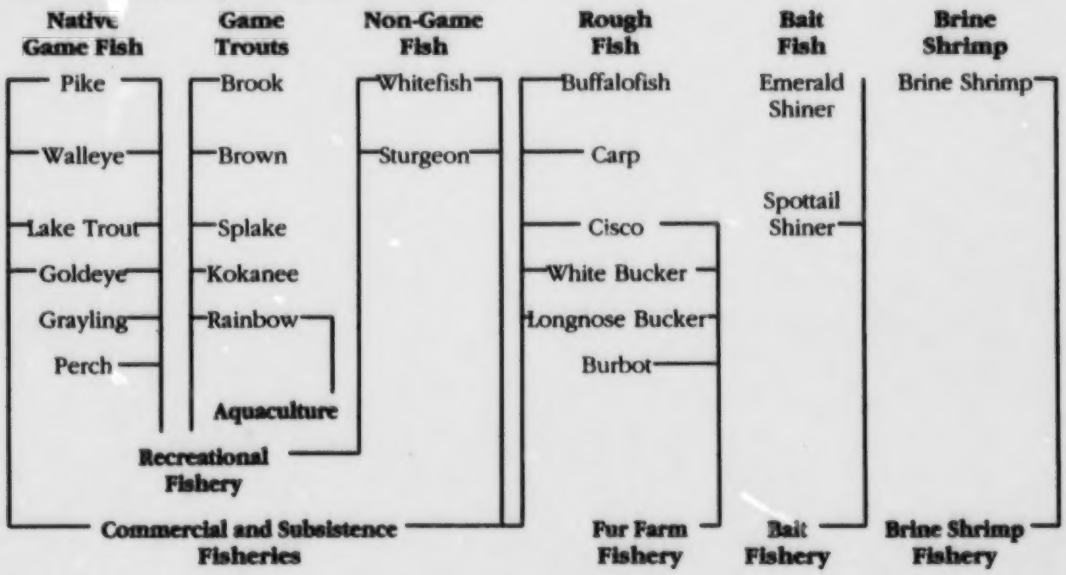
IN THIS SECTION...

- Saskatchewan people fish about 5 thousand of the province's 94 thousand lakes
- In the 1985-86 season, 9.7 thousand tonnes of fish were harvested
- Fishing contributes significantly to northern Saskatchewan's economy
- Fish populations are declining from over-harvest and habitat loss

Twenty-one of Saskatchewan's 68 fish species are commercially important enough to be managed and harvested (Figure 18). Several game trout species have been introduced for variety and to ease angling pressure on native species.

Saskatchewan's over 94 thousand lakes cover an area of more than 66 thousand km^2. Most of these lakes (89% of the number; 73% of the area) are on the Canadian Shield. About 50 thousand contain fish, though only about 5 thousand of them are fished. The rest are too small, shallow or naturally acidic or saline to sustain fisheries.

Figure 18:
Commercial Fish Species in Saskatchewan



ECONOMICS

Saskatchewan harvested 9.7 thousand tonnes of fish in 1985-86. Anglers (recreational fishermen) took 43%, commercial net fishermen 38% and subsistence fishermen the rest (Table 7). Native game fish comprised 72% of the catch.

Some native fish are over-harvested: walleye (Central and Northern Management Zones [Figure 19]), lake trout (Northern Management Zone), and pike and whitefish (Southern Management Zone). Some fish supplies have been successfully increased but aquatic ecosystems have production and harvest limits.

The total expenditure on recreational, commercial and subsistence fisheries was $78.9 million in 1984-85. That amount resulted in an estimated $58.2 million in gross domestic product (GDP), $38.3 million in wages and 1,900 person-years of employment. Anglers spent more than commercial and subsistence fishermen, whose income and employment impact was about 12% that of anglers.

MANAGEMENT

Between 1975 and 1985, the provincial harvest of walleye, pike, lake trout and whitefish declined about 1.4 thousand tonnes from over-fishing and habitat loss. Each year, about 230 lakes are stocked with 25 to 45 million game trout and other fish to ease angling pressure on native species and increase variety.

The Fish and Wildlife Development Fund (WDF) enhances fishing opportunities. Set up in 1984 to improve habitat and rehabilitate lakes, WDF has contributed $5.0 million to about 100 fish enhancement projects. Sixty of these projects are cooperative ventures with local conservation groups and other agencies.

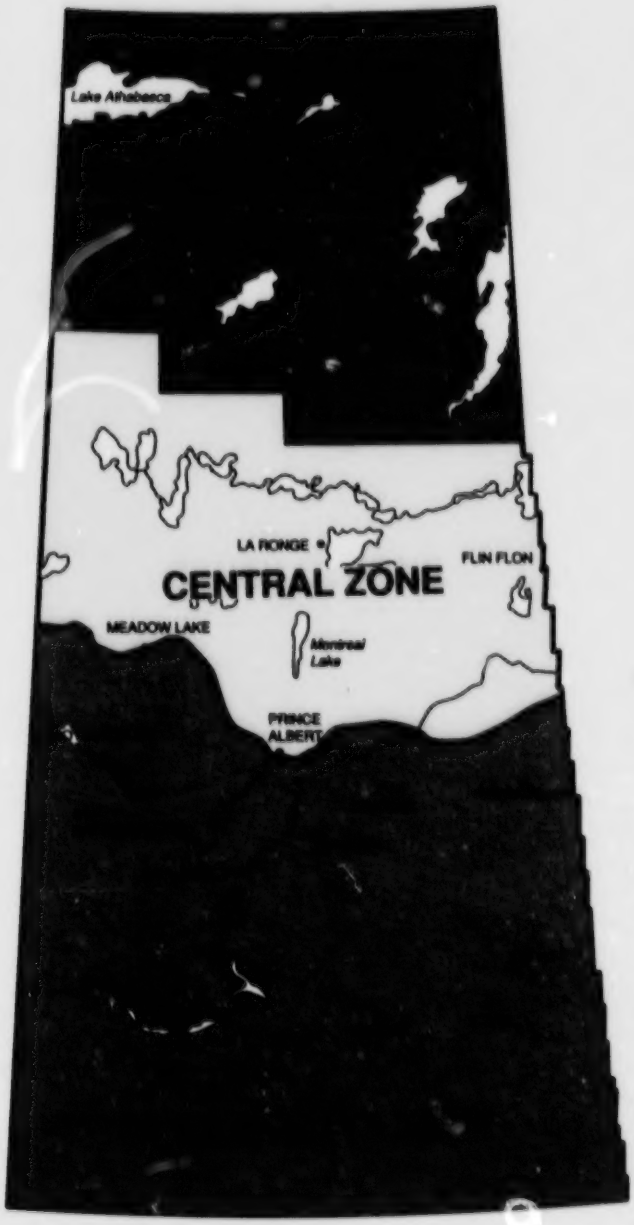
The government consults fisheries users on management or harvesting proposals. This involvement in the management process will help fisheries users resolve future excess demand problems themselves.

Table 7:
Estimated Harvests of Fish, 1985-1986[5] (000 tonnes)

	Native Game Fish	Game Trout	Non-Game	Total
Recreational	4.0	0.1	0.1	4.2
Commercial	1.8	..	1.9	3.7
Subsistence	1.2	..	0.6	1.8
Total	7.0	0.1	2.6	9.7

5 The year 1985-86 is the most recent year for which harvest estimates for all fisheries are available.

Figure 19:
Fisheries Management Zones



DOWN THE ROAD...

- Fisheries Strategic Plan for the 1990s should be implemented.

RESOURCES

IN THIS SECTION...

- Saskatchewan has approximately 400 wildlife species
- Hunting contributed over $210 million to the economy in 1987
- Human activities affect wildlife and habitat in every ecological zone
- Numbers and status of threatened or endangered species may be an indicator by which to evaluate the state of Saskatchewan's environment

The term *wildlife* refers to all vertebrates (except fish): big game, waterfowl, upland birds, furbearers, non-game species, reptiles and amphibians. Saskatchewan administers hunting seasons for 39 of its 400 wildlife species, and trapping seasons for 18 furbearers.

ECONOMICS

Big game and game bird hunting contributes to Saskatchewan's economy, though game harvest rates vary from year to year (Figure 20). In 1987, hunters spent $42.3 million on licenses, $90 million on wildlife-related trips and another $91.5 million on wildlife-related activities (such as art). The number of licenses issued for hunting has been decreasing during the past decade (Figure 21).

Figure 20:
Big Game and Game Bird Harvest Rates, 1980-1989

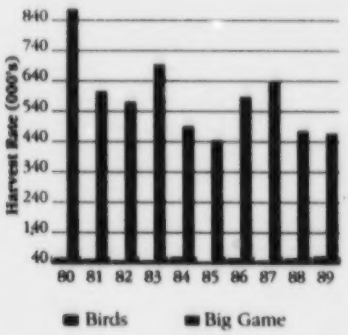
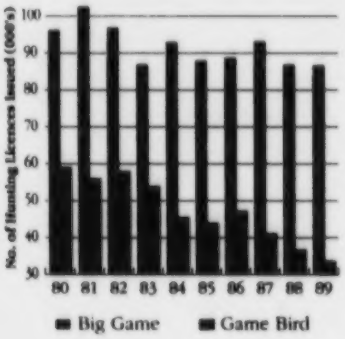


Figure 21:
Hunting Licences Issued, 1980-1989



MANAGEMENT

Each of Saskatchewan's six major ecological zones (Figure 22) has unique wildlife management challenges. For example, drought or severe winter storms can restrict available habitat in the Grasslands, affecting its common game species: mule deer, antelope, migrating geese, Hungarian partridge and sharp-tailed grouse. Most of Saskatchewan's endangered species live in the Grasslands zone.

In contrast, loss or degradation of wetland or wooded habitat and poaching are key management issues affecting white-tailed deer, waterfowl and sharp-tailed grouse in the Parklands.

Throughout Saskatchewan, wildlife and habitat are affected by land drainage and clearing, soil, water and air pollution, and road or transmission line construction.

Big Game

Saskatchewan's big game populations are generally stable following the past decade's mild winters (Table 8). However, black bear populations have declined in some areas from heavy hunting that followed population crashes in other jurisdictions. Mule deer, antelope, elk and white-tailed deer (in some areas) with good winter survival and reproduction rates, cause crop depredation in some agricultural areas. In winter, this problem is intensified because of high wildlife population densities, and the reduced ability of natural range to support large numbers of wildlife. The loss of natural ranges has been attributed to agricultural land development and drought.

Game Birds

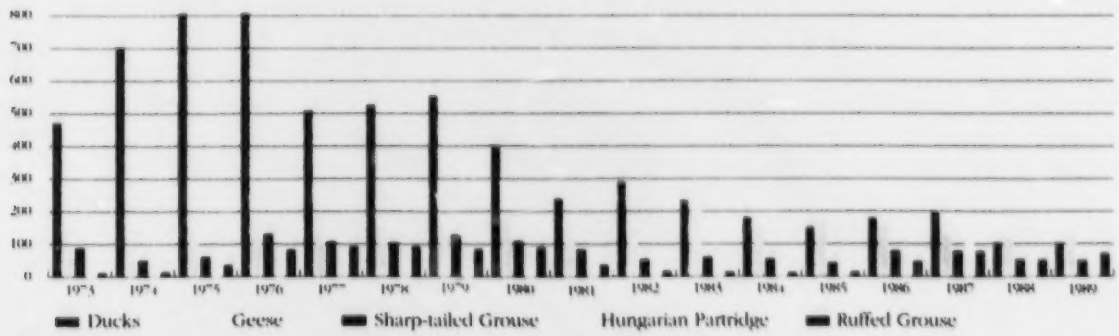
Bird populations varied in the 1980s (Figure 23). While arctic nesting goose populations remained stable, recurring drought and disappearing nesting habitat contributed to a noticeable population decline for almost all waterfowl breeding in Saskatchewan.

The 1988 drought also affected upland birds. Coupled with continued habitat loss, sharp-tailed grouse reproduction indices and harvests declined. Hungarian partridge and pheasants benefited from mild winters with little snow and maintained or slightly increased their populations. The ruffed grouse population decline (since 1988) is normal in their 9 to 10 year population cycle.

Table 8:
Status of Big Game Populations, (000)

Species	Mid-1970s[6]	1990[7]
Antelope	5.0	15.0 to 20.0
White-tail Deer	260.0	200.0 to 250.0
Moose	38.0	30.0
Elk	2.4	8.0
Mule Deer	30.0	40.0 to 50.0
Woodland Caribou	5.0	+5.0
Bear	30.0	20.0
Barren-ground Caribou[8]	Estimates are similar to 1990s	Unknown Beverly = 335.0 Kaminuriak = 320.0

Figure 23:
Annual Harvests of Game Birds, 1973-1989, (000)



6 Saskatchewan Parks and Renewable Resources. 1980. Saskatchewan Big Game Management Objectives for the 80s.

7 Estimates supplied by Saskatchewan Parks and Renewable Resources.

8 Only part of these herds come into Saskatchewan; Kaminuriak only occasionally.

Figure 22:
Wildlife Management Zones

MANAGEMENT PROGRAMS

The Saskatchewan government, in cooperation with wildlife agencies, has established protection and development programs to combat habitat loss (Table 9).

Table 9:
Wildlife Programs

The Critical Wildlife Habitat Protection Act	Originally passed in 1984, the Act dedicates approximately 1.4 million hectares of Crown land to wildlife production in conjunction with some traditional land uses (such as grazing). The Act responds to habitat loss from large scale clearing and/or breaking during the 1970s, and recognizes that wildlife production and habitat conservation are important environmental functions for Crown land.
Barren-ground Caribou Management Board	Established in 1982, the Beverly-Kaminuriak Caribou Management Board is to coordinate all aspects of migratory caribou management in Saskatchewan as part of a cooperative federal, provincial and territorial board.
Heritage Marsh Program	The Heritage Marsh Agreement between the Saskatchewan government and Ducks Unlimited (DU) was signed in 1982. The program evolved into a cooperative program among government, DU, Saskatchewan Wildlife Federation, Saskatchewan Natural History Society and Wildlife Habitat Canada to preserve and enhance major waterfowl marshes in Saskatchewan. The program provides waterfowl crop damage control through bait stations and lure crops.
Prairie Pothole Project	Started in 1986, the Prairie Pothole Project secures duck breeding habitat and creates nesting cover on private agricultural lands. The Saskatchewan government administers the project with financial support from Wildlife Habitat Canada and technical support from the Canadian Wildlife Service of Environment Canada.
Project Wild	Project Wild is an ecologically oriented package of information and teaching activities for the Saskatchewan science education curriculum grades K-12. The first workshop was presented in 1985.
Threatened and Endangered Species	A five year agreement between Saskatchewan and the World Wildlife Fund provides annual funds to the Saskatchewan Endangered Species Fund, designated for population monitoring and recovery plans to ensure no native wildlife species declines into jeopardy or becomes extinct.
Wildlife Development Fund	Established in 1970, the Wildlife Development Fund enables acquisition and management of critical wildlife habitat. The fund has acquired over 42 thousand hectares for wildlife protection and production.
North American Waterfowl Management Plan	Established in 1988, NAWMP is a five year project to restore continental waterfowl populations through cooperative international funding of programs securing waterfowl breeding habitat in prairie Canada. Since January 1990, the Saskatchewan Wetland Conservation Corporation administers NAWMP.

FOCUS ISSUE 3:

Endangered Species

Numbers and status of threatened or endangered species help evaluate the state of the environment in Saskatchewan. Some species' numbers are so small that even very minor alterations to their environment could jeopardize their future existence. Table 10 identifies threatened, endangered or vulnerable wildlife species in Saskatchewan currently listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Table 10:
Species at Risk, June 1990

	Mammals	Birds
Extirpated	Black-footed ferret**	Greater prairie chicken**
	Swift fox**	
Endangered		Eskimo curlew
		Peregrine falcon (subspecies anatum)*
		Piping plover*
		Whooping crane*
Threatened	Prairie longtailed weasel**	Baird's sparrow
	Wood bison	Burrowing owl*
		Ferruginous hawk*
		Loggerhead shrike**
		Peregrine falcon (subspecies tundrius)
Vulnerable	Black-tailed prairie dog	Caspian tern
	Plains pocket gopher	Cooper's hawk
	Southern flying squirrel	Eastern bluebird
	Western wolverine	Great grey owl
	Western woodland caribou	Trumpeter swan
Delisted		White pelican

* National recovery plans prepared.
** National recovery plans to be completed in 1991-92.

Extirpated: Native species no longer known to exist in the wild in Canada but existing elsewhere.

Endangered: Native species threatened with imminent extirpation or extinction throughout all or significant portions of its Canadian range due to human action.

Threatened: Native species likely to become endangered in Canada if factors affecting its vulnerability are not reversed.

Vulnerable: Native species particularly at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, but not threatened.

The Saskatchewan government is working with the federal government, university and non-government interest groups on various species and habitat problems. The research has produced species recovery plans for endangered species in Saskatchewan and recommendations for improved deer and waterfowl management. Planned research projects using Conservation Data Centres and Geographical Information Systems will supplement existing data bases to make data more applicable to research needs.

DOWN THE ROAD...

- Continue to develop and implement plans for rare and endangered species.

IN THIS SECTION...

- Forests cover almost half of Saskatchewan's total land area
- Over 10% of Saskatchewan's land area is commercially productive forest
- Saskatchewan forestry provides 1 in 55 jobs, over $50 million in wages, over $250 million in products and indirect revenue to other economic sectors
- The Saskatchewan government manages harvest and reforestation under user agreements, and reforests burn or backlog areas on Crown lands
- Integrated resource management plans accommodate multiple forest land uses

Forests cover 29.9 million hectares, or 46% of the province's total land area and are predominantly in northern Saskatchewan. Two-thirds are considered *productive*: they can or do support a marketable stand. Forest composition varies with the physical and climatic differences between *ecoregions*: regions where distinct vegetation, soil, fauna and water systems develop as a factor of climate (Figure 24).

The Southern Boreal Ecoregion has the most productive forests. Temperature and moisture conditions support a mixed deciduous and coniferous forest with jack pine, aspen and black spruce dominating.

The colder temperatures and shorter growing season of the Northern and Subarctic Boreal Ecoregions result in scattered, slow growing stands of black spruce, white birch and jack

Figure 24:
Ecological Regions of Saskatchewan

Legend

Subartic Boreal Ecoregion
1a ..... Northern Transition Ecodistrict

Northern Boreal Ecoregion
2a ..... Athabasca South Ecodistrict
2b ..... Northern Coniferous Ecodistrict

Southern Boreal Ecoregion
3a ..... Upper Churchill Ecodistrict
3b ..... Mixedwood Ecodistrict
3c ..... Manitoba Lowlands Ecodistrict
3d ..... Mixedwood-Parkland Transition Ecodistrict

Parkland Ecoregion
4a ..... Aspen Grove Ecodistrict
4b ..... Aspen-Bur Oak Ecodistrict

Grassland Ecoregion
5a ..... Mixedgrass Prairie Ecodistrict
5b ..... Sandhill Complex Ecodistrict
5c ..... Shortgrass Ecodistrict

Cypress Hills Ecoregion
6a ..... Lodgepole Pine-Fescue Prairie Ecodistrict

Ecoregion Boundary
Ecodistrict Boundary

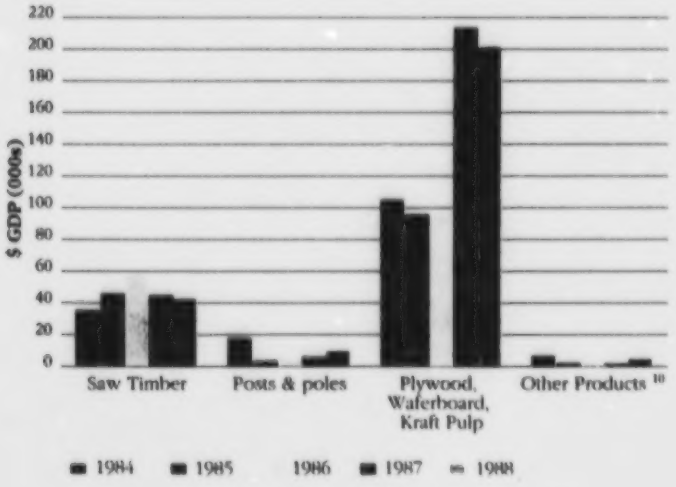
pine among rock outcroppings and bog.

Low precipitation restricts forest growth south of the Southern Boreal Ecoregion. The Parkland Ecoregion has interspersed aspen groves and grasslands; the Grassland Ecoregion has trees confined to moist environments along river valleys. However, the Cypress Hills Ecoregion has lodgepole pine.

Thirteen native tree species have commercial value. White spruce, the most harvested, is used for pulp, paper, plywood and lumber. Jack pine (pulp, railway ties and poles) and black spruce (pulp) are the next most used softwoods. Balsam fir, tamarack and lodgepole pine have less commercial value.

Trembling aspen and balsam poplar, both hardwoods, supply the pulp, paper and wafer board industries. Remaining commercial hardwoods (bur oak, white birch, green ash, white elm and Manitoba maple) have only local value.

Figure 25:
Contribution of Selected Forest Products to Saskatchewan GDP, 1984-1988



ECONOMICS

Forest products' value to Saskatchewan's gross domestic product (GDP) increased 56% between 1984 and 1988, $166 million to $259 million, representing 1.01% and 1.41% of GDP respectively. In 1988, plywood, wafer board and kraft pulp represented about 78%, and saw timber 16% of the industry's GDP contribution (Figure 25).

One of every 55 Saskatchewan jobs directly or indirectly depends on forestry.[11] In 1985, forestry provided 3,235 person-years of direct employment (over 1% of Saskatchewan's employed labour force) and indirectly, another 4,669 person-years.

The Canadian Forestry Service estimates that in 1985, forestry generated $54 million in wages and salaries, or 11.3% of all manufacturing sector wages in Saskatchewan. The Canadian average is 14.1%. Logging generated an additional $15.6 million in Saskatchewan, compared to $1.3 billion for all of Canada.[12]

Saskatchewan forests contribute directly to several other sectors. Big game hunters spent about 144 thousand hunter-days in the forest fringe in 1988, generating $1.1 million in license revenues and $700 thousand for Wildlife Habitat Certificates (game bird licenses). Hunters and anglers also spent money on transportation, accommodation, guides, food, equipment and other services.

9 Saskatchewan Bureau of Statistics. 1989. Economic Review 1989. Number 43 (December)

10 Includes rails, ties, piling and round timber and fuel wood.

11 Samoil, J.K. and Boughton, B., eds. 1987. Saskatchewan's Forests in Forest Report. Number 33 (June).

12 Ibid.

Figure 26:
Saskatchewan's Forest Zones

FOREST MANAGEMENT ZONES

Most of the province's forested lands are Crown land. These forested Crown lands have been divided into two categories: the Commercial Forest Zone and the Northern Reconnaissance Zone (Figure 26). The area in hectares of productive and non-productive forests is illustrated in Figure 27.

Historically, the term Commercial Forest Zone was used only to describe timber values. Now, forestry companies and the Saskatchewan government are developing integrated resource management plans for sustainable development of all forest based resources and activity.

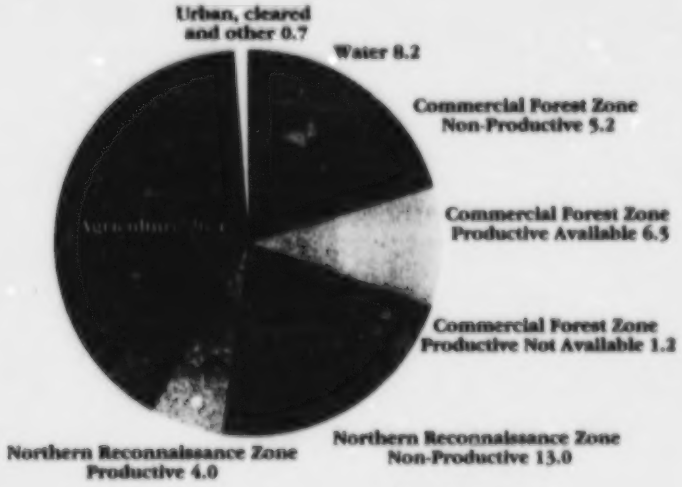
MULTIPLE USE OF FOREST LANDS

In the Parkland and Southern Boreal Ecoregions, cattle and sheep graze some forested areas. Saskatchewan forests provided an estimated 119 thousand *animal unit months* (forage provided for one mature animal with calf for one month) of grazing in 1984-85.[11]

Forests also yield several products that can be gathered: blueberries (from young pine cutovers), mushrooms (from native forests), and chokecherries and Saskatoon berries (from sparse poplar woodlands).

Forests are increasingly used for both consumptive and passive recreation. Forest management plan development must therefore consider increased access to recreation sites and reserves.

Figure 27:
Forest Zone Productivity[14]
Area of Saskatchewan (000,000 ha)


Urban, cleared and other 0.7
Water 8.2
Commercial Forest Zone Non-Productive 5.2
Commercial Forest Zone Productive Available 6.5
Commercial Forest Zone Productive Not Available 1.3
Northern Reconnaissance Zone Non-Productive 13.0
Northern Reconnaissance Zone Productive 4.0

TIMBER ALLOCATION SYSTEM

The Saskatchewan government is responsible for managing the provincial forest (on Crown land) and allocating harvesting rights. A tenure system allocates cutting privileges in exchange for Crown dues and certain forest management obligations. Three allocation methods are in place.

Forest Management Licence Agreements (FMLAs)

About two-thirds of the Commercial Forest Zone is under FMLAs[15]. An FMLA is a negotiated agreement between the Minister of Parks and Renewable Resources and a forest company. About 66% of the total harvested *roundwood* (limbed trees, ready to be cut into lengths) is managed through the FMLA process.

FMLAs negotiated since 1986 share four important characteristics.

- An FMLA has a twenty year term. After five years, the agreement is reviewed. If performance of the Licensee is satisfactory, the agreement is extended for another five years.
- The Licensee must maintain long-run sustained yield on the license area and submit five and twenty year management plans. It must also administer the reforestation fund.
- Stumpage and reforestation fees are payable at rates negotiated in the FMLA.
- An FMLA gives the Licensee the rights to harvest all merchantable timber, less volumes reserved for small operators. Other uses of the area (skiing, hunting, fishing, hunting, gathering and trapping) are not restricted.

Timber and Field Permits

The remainder of Saskatchewan's roundwood harvest is allocated by permits. Timber permits are issued for commercial purposes; field permits for domestic use. In 1989-90, a total of 1,339 timber and 4,225 field permits were issued. Permits are issued for a maximum one year period. All permittees pay stumpage fees according to the regulations. Eligible operators may harvest volumes up to a regional quota level.

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14 Ibid.

15 Steele, T.W. et al. 1988. Ssskatchewan's Forest Industry, 1985. Information Report NOR-X-295. Edmonton, Alberta: Canadian Forestry Service, Northern Forestry Centre.

Term Cutting Agreements

Cutting agreements are intended for small operators to give them more security in exchange for greater responsibility for planning. Term cutting agreements stipulate that:

- a cutting agreement of up to 10 years may be signed to provide the operator with some form of security; and
- the signee will have to provide a formal harvest plan to the Department of Parks and Renewable Resources.

The term cutting agreement holder is required to pay regulation stumpage rates and a reforestation fee. A term cutting agreement assigns a guaranteed volume of wood. At present, there are no signed term cutting agreements in the province. In the future, many independent operators will likely be covered under this agreement.

REFORESTATION

Reforestation activities undertaken by the provincial government are focused on burns and backlog areas. New FMLAs signed since 1986 require that companies and small operators harvesting on FMLA areas pay into a Reforestation Trust Fund according to the volume of wood harvested. The money in these funds is to be used by the company for reforestation activities. Companies are required to maintain the long term forest productivity of their FMLA areas. Every five years, the funds are reviewed to ensure that they are adequate to maintain this productivity. If not, amounts paid into the funds may be adjusted.

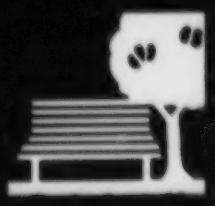
AGRO-FORESTRY

Some Saskatchewan groups and individuals are combining agricultural and forest management practices. They use shelterbelts, woodlots, intercropping and managed forest grazing to support soil conservation and economic diversification.

Agro-forestry practices work towards economic sustainability and resource conservation in agriculture and forestry. They can also improve wildlife habitat and produce non-traditional crops on forest lands.

DOWN THE ROAD...

- Identify trends in agro-forestry.



D S

IN THIS SECTION...

- Saskatchewan's parks preserve natural and cultural resources
- Protection and use determine park and site classification
- Parks' employment and visitor spending contribute to local and provincial economies
- The new Parks System Plan proposes park expansions and new designations

Table 11:
Park Land Base[16]

	Number of Designations	Area (000 hectares)
Provincial Parks		
Recreation Parks	10	8.9
Natural Environment Parks	11	666.6
Historic Parks	9	0.3
Wilderness Parks	1	224.0
Total:	31	899.8
Protected Areas		
Archaeological/Historic	14	0.5
Natural	7	20.1
Total:	21	20.6
Recreation Sites	169	42.5
Historic Sites	8	<0.1
Provincial Markers	149	—[17]
Parks Land Reserve	1	1.3
Total Park Land Base:	379	964.2
Park Land Base as Percentage of Total Provincial Area[18]		1.47%

Saskatchewan's park lands have a multiple role: they preserve and protect natural and cultural resources for future generations; provide recreation, education and interpretive opportunities; and, contribute to Saskatchewan's social and economic well-being.

The provincial government is responsible for the management of park lands under The Parks Act, passed in 1986. The Act enables government to:

- designate areas with park potential as Park Land Reserves;
- establish provincial parks to protect representative or unique features of Saskatchewan's natural and cultural heritage, and provide compatible forms of recreation;
- establish four classes of provincial parks (shown in Table 11);
- subdivide parks into management zones to guide the location of facilities and services, and management of the resource base;
- establish smaller land areas for specific uses (such as protected areas, recreation sites, historic sites);
- identify historic and natural points of interest with Provincial Markers; and,
- specify and regulate uses of park lands.

Table 11 shows provincial park areas by category. It does not include regional parks or urban park authorities because they are not gazetted under The Parks Act.

16 Saskatchewan Parks and Renewable Resources. 1990. Management of Saskatchewan Park Lands - A Guide to Saskatchewan's Park Lands and How They Are Managed.

17 No associated land base.

18 Based on a provincial land area of 65.2 million hectares.

ECONOMICS

Provincial parks make an economic contribution to nearby communities and the province. Natural environment, recreation and wilderness provincial parks reported about 3.7 million visitors while 4 historic parks reported 29 thousand visitors in 1990. Approximately 588 thousand campers visited provincial natural environment and recreation parks in 1990.[19]

In the 1989-90 season, park visitors spent approximately $25.5 million. Combined with the $16.6 million the government spends annually on parks, the Saskatchewan economy gained over $40 million dollars. Recent research indicates that every dollar spent on parks goods and services, generates an additional $0.55 in indirect spending, bringing the total revenue attributable to parks to about $65 million dollars annually.

Parks also have an impact on employment. Provincial parks provide 250 person-years of employment, while park visitor spending generates another 210 person-years. Enterprises in 94 communities within 60 km of provincial parks, generated $9.3 million toward the GDP. This resulted in a further 99 person-years of employment to park-related sectors.[20]

FOCUS ISSUE

Parks System Plan

The government released a Parks System Plan in December, 1990. The plan suggests some park expansions, and where new ones could be established. The plan examines the representation of Saskatchewan's 6 natural regions and 31 natural zones, recreation travel patterns and demand, and land capability for recreation.

Existing parks represent 3 natural regions and 11 natural zones well, and moderately represent another 2 natural regions and 10 natural zones. The plan proposes 27 new park land designations: 9 natural environment and 4 wilderness parks, 12 protected areas, and 2 undefined designations (on the Churchill River) still being researched. The proposed designations will increase natural region representation and landform protection.

The Parks System Plan was developed to:

- ensure that land use changes do not limit availability of suitable park areas;
- clarify park roles, enabling visitor programming and facility development policies for existing parks; and,
- meet the objectives of the Endangered Spaces/Canadian Wilderness Charter Campaign which suggests that all provinces and territories have a Parks System Plan in place by 1990, and the plan fully implemented by the year 2000. The Charter also suggests that each province and territory should designate 12% of its land and water base as Conservation Lands.

DOWN THE ROAD...

- Continue with public consultation on the Parks System Plan and undertake research on several candidate park areas.

19 Saskatchewan Parks and Renewable Resources. 1990. 1990 Summer Visitation & Outdoor Recreation Statistical Report.

20 Saskatchewan Parks and Renewable Resources. 1990. Saskatchewan Park Lands: Benefits and Provincial Park Descriptions. Report 90.3.

AGR

IN THIS SECTION...

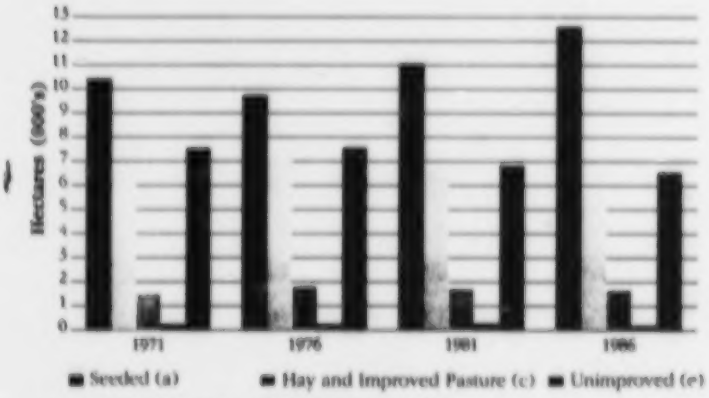
- In Saskatchewan, agriculture uses about 47% of the land area
- Saskatchewan has over one-third of Canada's best agricultural land
- Agriculture has had an impact on soil quality and wildlife habitat
- Farming methods affect soil erosion, salinity and organic matter content

Table 12:
Canada Land Inventory Classification[21]

CLI Class	Definition	Area in Saskatchewan (000 hectares)
1	Very good arable	1,043
2	Good arable	5,315
3	Fair arable	8,691
4	Poor arable	3,291
5	Improvable pasture	6,972
6	Rough pasture	2,505
7	No capacity for arable culture or permanent pasture	199
Organic	Soils not rated by capability classes	315
Total		28,331

Since Saskatchewan's settlement, some 20 million hectares of Saskatchewan land have been broken for agriculture. On average, the primary industries including agriculture, forestry, mining and fishing contribute $3.3 billion or 21.2% to the province's gross domestic product (GDP). Of this total, primary agriculture contributes $1.9 billion, or 12.2% to the GDP.

Figure 28:
Agricultural Practices, 1971-1986[22]



(a) seeded to annual crops
(b) including conventional summerfallow, chemical fallow and green manur crops
(c) seeded to domestic species of perennial forages
(d) building sites, gardens, roadways, etc.
(e) native pasture, water bodies and other undeveloped land

21 Saskatchewan Institute of Pedology. Inventory of Saskatchewan Soils and Their Capability for Agricultural Use. Publication Number M13.

22 Statistics Canada 1986.

LAND USE

Of Saskatchewan's 65.2 million hectares, 26.6 million are used for agriculture. In terms of total area, agriculture has had a major impact on Saskatchewan's environment.

The federal government's Canada Land Inventory Classification rates land for agricultural suitability (Table 12). Saskatchewan has 28.3 million hectares of classified land, of which approximately 53% is class 3 or better. Of all Canada's class 1, 2 or 3 land, 36% is in Saskatchewan.

Market and economic conditions, climate (moisture) and farming practices all affect agricultural land use in Saskatchewan (Figure 28).

FARM INCOME

Saskatchewan agriculture depends on export markets and is influenced by global economic conditions. Weather is also critical in a semi-arid climate where low moisture can limit production. Farm income changes for the last two decades reflect these factors (Figure 29).

FARM SIZE

Larger equipment, the cost-price squeeze, economies of scale and a trend to specialization have all contributed to increasing farm size and decreasing farm numbers (Figure 30).

Figure 29:
Cash Receipts, Expenditures and Income from Farm Operations, 1971-1989[23]

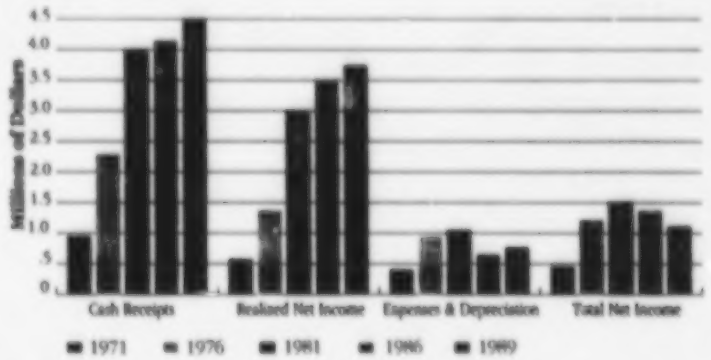
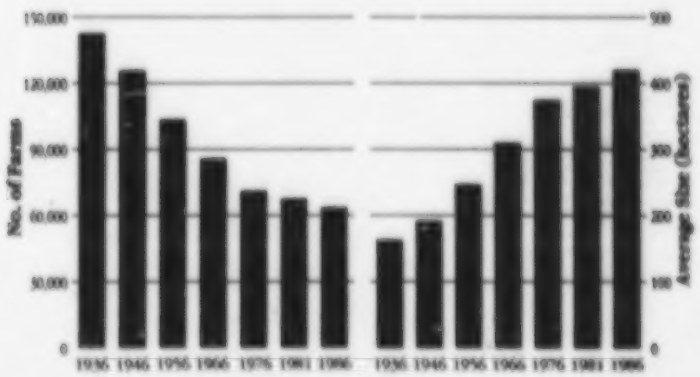


Figure 30:
Average Farm Size and Number of Farms, 1936-1986[24]



23 Ibid.

24 Ibid.

MIXED FARMING

Many farm operations include livestock. Farms vary from cattle operations using large native pastures, to intensive operations producing hogs or poultry. Livestock farming provides an alternate use for lands unsuited for grain production and helps to diversify income sources. Table 13 shows livestock numbers from 1971 to 1990.

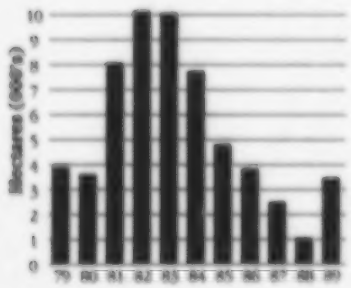
Table 13:
Livestock on Farms, 1971-1990, (000)[25]

	1971	1976	1981	1986	1990
Cattle and calves	2,645	3,080	2,401	2,056	2,160
Sheep and Lambs	145	85	76	53	56
Pigs	1,090	493	560	609	790
Fowl and Chickens[a]	9,141	8,712	9,378	10,770	n/a
Turkeys	687	611	598	662	n/a
Horses	65	56	60	67	n/a

IRRIGATION FARMING

In Saskatchewan's drier areas, irrigation projects supplement natural precipitation. Irrigation can increase both crop yield and the variety of crops that can be produced. Many livestock producers find irrigation makes feed supply more reliable. Irrigation varies from small, back-flood projects to large scale, multi-use projects such as the Luck Lake development. Figure 31 illustrates irrigation development since 1979.

Figure 31:
Total Area Developed for Irrigation, 1979-1988



IMPACTS OF AGRICULTURE

Wildlife

Breaking 20 million hectares for agriculture has significantly changed southern Saskatchewan's landscape and had an impact on wildlife. Large expanses of cultivated crop land offer only limited habitat for most species.

Some recent land use programs emphasize multiple use. The Save Our Soils Program encourages planting field shelterbelts to control wind erosion and provide wildlife habitat. The North American Waterfowl Management Plan encourages landowners to preserve suitable water and land areas for waterfowl habitat.

Soil Degradation

Soil degradation threatens long term productivity of cultivated land. Wind and water erosion, organic matter loss and salinity are the most serious threats to Saskatchewan's soil.

- **Erosion**

Erosion by wind and water results primarily from insufficient trash cover. An estimated 8 million hectares are at high risk of wind and water erosion. Prolonged drought aggravates erosion, while longer crop rotations, reduced summerfallow and tillage, strip or contour farming, shelterbelts and seeding to perennial forages help control erosion.

- **Organic Matter Loss**

Organic matter (plant and animal residues) is important to soil fertility. It releases nitrogen, improves soil's moisture-holding capacity, improves soil texture and reduces the risk of wind erosion. Organic matter content in uncultivated soils reaches an equilibrium appropriate to available moisture and plant cover type. Cultivation and frequent summerfallowing (when little or no organic matter

25 Ibid.

26 Annual production.

is produced), has reduced organic matter content of Saskatchewan soils.

Saskatchewan's cultivated lands have lost approximately one-half the original organic matter. Exact loss rates vary with agricultural practices over time. Longer crop rotations, perennial forages, reduced tillage, crop residues and use of *green manure* (plow down crops) or livestock manure can all increase soil's organic matter. Table 14 provides an estimate of organic matter decline on various soils.

Table 14: Percentage Organic Matter in Various Soil Zones

Soil Association	Textural Class	Soil Zone	% Organic Matter in Uncultivated Surface	Estimate of % Organic Matter Remaining After 7 Years of Cultivation
Haverhill	Loam	Brown	3 to 4%	2%
Regina	Heavy Clay	Dark Brown	4 to 5%	3%
Oxbow	Loam	Black	7 to 8%	5%
Melfort	Silty Clay Loam	Deep Black	12 to 15%	9%
Shellbrook	Fine Sandy Loam	Greyish-Black	6 to 7%	5%
Waiteville	Loam	Grey-Wooded	3 to 4%	3%
Pine Sands				1%

- **Soil Salinity**

Soil salinity occurs naturally in Saskatchewan, when salts accumulate at or near the soil surface. Approximately 2 million hectares are affected to some degree, and 240 thousand hectares have seriously impaired productivity.

In some areas, irrigation or summerfallowing can aggravate salinity. When irrigated soil becomes saturated, excess water gravitates to low lying areas where it collects, dissolves soil salts and evaporates, leaving the salts at or near the soil surface. Summerfallowing results in water evaporating from the soil surface. Sub-surface moisture moves upwards, transporting dissolved salts which are deposited at or near the soil surface.

Limiting fallow land, using deep rooted and salt tolerant crops (particularly perennial forages) and managing recharge areas to avoid saturation can all reduce salinity's effects.

Livestock Production

Livestock and poultry operations have minimal negative impact on our environment. The Pollution (By Livestock) Control Act, 1984 regulates the location of livestock operations to protect water quality and minimize nuisance effects from flies and odour. Livestock operations can aid soil conservation through demand for forage crops and addition of manure to cultivated land. Land available for manure treatment exceeds supply.

Pesticide Management

Agricultural pesticides include materials to control insects, fungi, weeds and other pests which could damage crops. Most pesticides used in Saskatchewan are herbicides, with 2,4-D being the most common.

Saskatchewan's climate, farming methods and farming intensity demand less pesticide use than elsewhere in the world. Water quality monitoring has not identified pesticide contamination exceeding water quality guidelines.

Pesticide use, distribution, and handling is regulated under The Pest Control Products (Saskatchewan) Act. Monitoring and enforcement have increased recently, as has research and development in biological pest control and integrated pest management systems.

FOCUS ISSUE 5:

The Canada-Saskatchewan Agreement on Soil Conservation

In 1989, federal and provincial governments signed the Canada-Saskatchewan Agreement on Soil Conservation to address soil degradation. The agreement provides $54 million in funding to reduce soil degradation and promote conservation through on-farm demonstration projects, to plant shelterbelts, seed permanent cover on soils at high risk of degradation, convert salinized irrigated lands to other uses, and conduct research and public awareness programs. The agreement unites farmers, researchers, wildlife interest groups and government agencies to achieve a common goal of soil conservation.

FOCUS ISSUE 6:

The Agricultural Chemical Collection Program

The Saskatchewan government administers an Agricultural Chemical Collection Program. Started in 1990, the program offers an environmentally safe disposal method for old or unusable agricultural chemicals. In the first 25 weeks, the mobile collection depot served 98 rural municipalities, collecting 23.6 tonnes of agricultural chemical waste. The chemicals were shipped to the United States for incineration. This program will continue until 1993.

DOWN THE ROAD...

- Develop indicators for soil erosion, organic matter loss and salinization
- Evaluate the adoption of conservation practices by Saskatchewan producers

NON-RENEWABLE R

IN THIS SECTION...

- Non-renewable resources make up one-third of Saskatchewan's exports
- The sector provides direct employment to 10 to 14 thousand people
- Provincial and federal legislation regulates exploration and development, extraction and operation, pollution control, decommissioning, reclamation and abandonment
- Government undertakes necessary remedial action at operation sites abandoned before regulations were established

Saskatchewan derives much of its wealth from *non-renewable* resources (finite supply that can be exhausted over time). Oil, gas, potash, uranium, coal and gold are Saskatchewan's major non-renewable resources. Saskatchewan also produces small quantities of sodium sulphate, sodium chloride, sand, gravel, clays and base metals such as copper and zinc.

ECONOMICS

Non-renewable resources contribute to Saskatchewan's gross domestic product (GDP), employment, capital formation and trade. Between 1985 and 1989, the sector's GDP contribution varied from 5.5% to 11.4% with price fluctuations common to the sector. International markets determine prices for most products. In 1985, the sector accounted for 44% of provincial exports' value, due to high oil prices. In other years, the sector provides about one-third of total provincial exports.

Tables 15 and 16, and Figures 32 and 33 provide general statistics and trends for key resources from 1985 to 1989.

Table 15: Resource Production Volume (000)

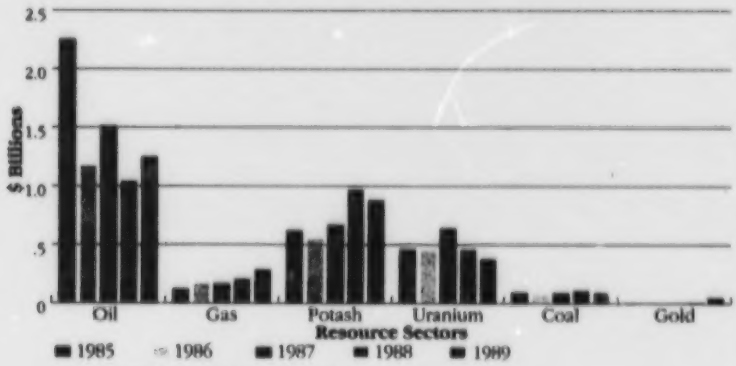
	1985	1986	1987	1988	1989
Oil (m^3)	11,613	11,698	12,075	12,269	11,696
Natural Gas (000 m^3)	2,401	2,748	3,098	4,588	6,156
Potash (tonnes)	10,511	9,888	10,572	12,085	10,670
Uranium (kg U_3O_8)	6,990	8,137	9,715	9,655	8,735
Coal (tonnes)	9,537	8,329	10,020	12,110	10,816
Gold (kg)	0.2	N/A	1,056	1,133	2,707

Table 16: Resource Sales Volume (000)[27]

	1985	1986	1987	1988	1989
Oil (m^3)	11,541	11,706	12,064	12,242	11,626
Natural Gas (000 m^3)	1,991	2,368	2,712	3,992	5,587
Potash (tonnes)	10,455	10,342	11,511	11,650	10,297
Uranium (kg U_3O_8)	7,337	7,444	11,223	8,416	7,695
Coal (tonnes)	9,537	8,329	10,020	12,110	10,816
Gold (kg)	0.2	N/A	1,056	1,191	2,844

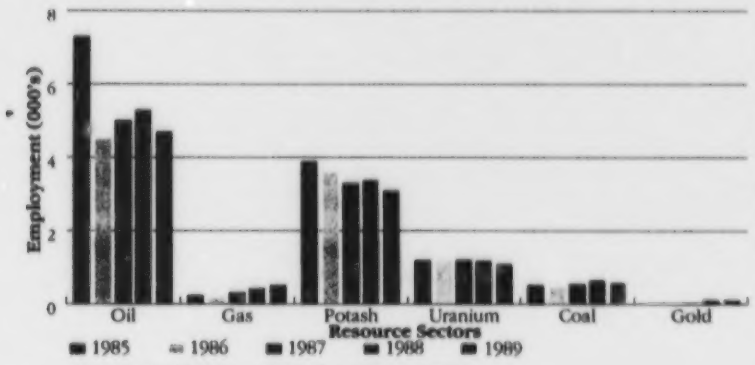
27 Production and sales volume differences are due to storage, or to resource use for processing or transport.

Figure 32: Value of Resource Sales ($ Billions)



Data for Gold in 1986 not available

Figure 33: Resource Sector Employment (000)



Data for Gold only available for 1988 and 1989

REGULATORY PROCESS

Although resource ownership and control is vested with the Province, both federal and provincial governments are responsible for environmental regulation and control. The most relevant federal regulations for Saskatchewan include the federal environmental assessment process, applicable to both mining and oil and gas sectors, and the Atomic Energy Control Regulations, applicable to uranium.

The Saskatchewan government regulates, licenses and monitors mining operations under The Environment Management and Protection Act, The Mineral Industry Pollution Prevention Regulations and The Potash Refining Regulations.

Saskatchewan Energy and Mines controls all aspects of environmental protection associated with oil and gas field operations (except air quality), by administering The Oil and Gas Conservation Act and The Pipe Lines Act. Provincial legislation prescribes equipment, standards and procedures the petroleum industry must follow in drilling, completing, producing and abandoning wells, and in treating, storing, and transporting and disposing of produced substances.

EXTRACTION

Extraction processes vary with the resource and its location, but generally include exploration, development, operation or production, reclamation, decommissioning and abandonment (Table 17).

Table 17:
The Extraction Process

Mining

Mining consists of five distinct phases. The environmental effects of each may differ. Environmental concerns vary with mine specific factors such as mine type (open pit or underground) or expected future land uses.

- Exploration

Exploration involves prospecting for mineral showings and may include mapping, geophysical work (seismic and magnetic surveys), sampling and analysis of rocks, soils, lake sediments and vegetation, trenching and stripping, and diamond drilling.

- Development

Development may include building a test mine as well as building the actual mine and mill. Production facilities include mines, mills, waste treatment facilities, with spaces for tailings containment (remnants after minerals have been removed from ore), ore storage, waste rock disposal, fuel storage and refuse disposal.

- Operation

In this phase, mining and processing ore requires handling and using fuels, chemicals and contaminated water. Treatment plants, holding areas and associated equipment are monitored to prevent spills, emissions or discharges to surrounding land, water or air.

- Decommissioning and Reclamation

Decommissioning involves permanently closing all production facilities. Reclamation stabilizes waste containment and disposal areas, and returns the area as nearly as possible to its pre-development condition. It includes ensuring area safety, preventing unacceptable contaminant releases, and making the area suitable for other uses.

- Abandonment

The final phase involves officially releasing the mining company from further liability and responsibility for the decommissioned and reclaimed mining development.

Oil and Gas Drilling

Oil and gas drilling occurs in four phases. Like mining, each phase may affect the environment differently.

- Exploration

Oil and gas exploration involves geological surveys, seismic work and drilling to evaluate resource quantity and quality. If oil and gas reserves are economically recoverable, development begins.

- Development

In this phase, wells are drilled and completed for production. Several measures are undertaken during this phase to prevent environmental damage. Blow out preventers are installed during drilling to prevent uncontrolled escape of gas, oil and/or water and mud seepage, and groundwater contamination is prevented by disallowing the storage of drilling mud in earthen pits in areas underlain by gravel deposits. Surface casing is cemented to the surface through potable fresh water horizons. When production casing is set, it is cemented to a sufficient height to prevent fluid or gas migration; protective dykes are built if there is a body of open water nearby.

- Production

During production, oil is pumped or flows from wells together with natural gas and salt water. Oil may be stored in tanks at the well or moved by flowline to a central battery. Gas and water are removed before oil moves through corrosion protected pipelines to the refinery. The water is either returned to the producing horizon or disposed of in deep wells.

- Abandonment

When a well is abandoned, cement plugs are installed to prevent any subsequent oil, gas or water leakage. Land is restored so previous land use can resume.

OIL AND GAS

Drilling for crude oil and natural gas in Saskatchewan began near Langham in 1906. Commercial natural gas was first discovered in 1934 and commercial crude in 1944, both near Lloydminster. Saskatchewan's other three main crude oil producing areas were discovered near Kindersley-Kerrobert (1948), and Swift Current (1952) and Estevan-Weyburn (1952). Natural gas was discovered progressively along the province's western border (Figure 34).

Drilling Mud Disposal

Drilling fluid disposal guidelines were developed in 1986, though most wells prior to this period used fresh water drilling fluids and encountered few disposal problems. In the mid-1980s, gas well drillers began using potassium chloride and other salt-based muds to keep the well bore in good condition. Because of disposal problems encountered with the high salt content system, operators were required to store potassium chloride drill mud in tanks instead of pits. On-land disposal was disallowed and operators were encouraged to investigate alternatives.

By 1989, operators were using calcium sulphate, ammonium sulphate or potassium sulphate drilling fluids. Disposal guidelines were developed for these fluids. To date, no significant environmental concerns from fluid use or disposal are evident.

Figure 34: Mineral Resource Map of Saskatchewan

OIL FIELDS

GAS FIELDS

U URANIUM

1- Lorado Mine (closed) and Uranium Ridge deposit
2- Gunnar Mine (closed)
3- Nesbitt Labine (Eagle-Ace) Mine and Beaverlodge Uranium prospect
4- Cluff Lake (Amok Ltd. 80 % Cameco 20 %) – 'D' deposit
5- Cluff Lake Mine (Amok Ltd. 80 % Cameco 20 %)– Dominique, Peter, 'OP' and 'N' deposit
6- Cluff Lake Mine (Amok Ltd. 80 % Cameco 20 %) – Claude deposit
7- Rabbit Lake Mine (closed) and Mill; deposit mined out – mill processing ore from Collins Bay 'B' Zone (Cameco 66.67%, Uranerz 33.33%)
8- Cigar Lake Test Mine (Cameco 48.75%, Idemitsu 12.875%, Comega 32.625%, Corona Grande 3.75%, Korea Electric Power 2%)
9- Key Lake Mine (Cameco 66.67%, Uranerz Exploration and Mining Ltd. 33.33%) – Gaertner and Deilmann deposit

G GOLD

1- Box Mine (closed)
2- Jolu Mine (Corona Corp. 30%, Intentional Mahogany Corp. 70%)
3- Star Lake Mine (closed) and Mill (deposit mined out – mill porcessing ore from Fork Lakes deposit Fork Lakes deposit – Jasper Mine)
4- Bootleg Lake/Rio Mine (closed)
5- Jasper Mine (Fork Lakes deposit) (Cameco 80%, Shore Gold Fund 20%)

P POTASH

1- Potash Corp. of Sask., Rocanville Div., potash mine
2- Int. Minerals and Chemical Corp. (Canada) Ltd., K1, potash mine
3- Int. Minerals and Chemical Corp. (Canada) Ltd., K2, potash mine
4- Potash Corp. of Sask., Lanigan Div., potash mine
5- Central Canada of Potash Company Ltd., potash mine
6- Potash Corp. of Sask. and Saskterra Fertilizers Ltd., Allan potash mine
7- Potash Company of America, potash solution mine
8- Potash Corp. of Sask., Cory Div., potash mine (by-product $CaCl_2$ brine)
9- Comico Ltd., potash mine
10- Kalium Chemicals Ltd., potash solution mine

C COAL (lignite coal mines)

1- Costello Mine – Manalta Coal
2- Utility Mine – Manalta Coal
3- Bienfait Mine – Estevan Coal Corp.
4- Boundary Dam Mine – Estevan Coal Corp.
5- Poplar River Mine – Prairie Coal Ltd.

Oily Wastes

Oily wastes are most prevalent in the Lloydminster and Kindersley heavy oil areas. Most operators build ecology pits (to Energy and Mines specifications) to temporarily store oil and other wastes. Material disposal from these pits is similar to disposal of oil from spills and tank clean-outs elsewhere in the province: oil is treated and sold, water disposed of in deep injection wells and sludge used as road dust suppressant or for road and dyke construction.

Oil and Salt Water Spills

Flowline breaks, or wellhead or battery equipment malfunctions, can cause oil and salt water spills in the field, while line breaks can cause oil spills along transmission pipelines. The Oil and Gas Conservation Regulations require operators to report all off-lease spills, and any on-lease spills greater than 10 barrels.

In 1990, 408 spills caused 693 cubic meters (m^3) of lost oil and 1,654 m^3 of lost salt water. Oil loss was less than 0.005 of 1% of total production, while salt water loss was less than 0.003 of 1% of the salt water produced with oil. In 1989, the industry lost 808 m^3 of oil and 1,639 m^3 of salt water through 592 spills. Oil lost as a result of spills is either retrieved mixed with dirt or sand, or is burned; it can not be recovered for sale.

Oil and Gas Well Blowouts

Saskatchewan's last uncontrolled blowout, in 1984, was the fourteenth since 1969. All blowouts occurred during drilling when high pressure gas zones were encountered, or when workers pulled the drill string without adequate hole fill. In all cases, the gas was *sweet* (no hydrogen sulphide) and the blowouts were quickly controlled with no lasting environmental damage.

Gas Venting and Flaring

In 1989, an estimated 222 million cubic metres of natural gas was flared and vented into the atmosphere. Most was produced in small volumes along with oil from hundreds of different battery and well sites, and was therefore uneconomic to recover. The many measurement sources and measurement accuracy limit this estimate's reliability.

Decommissioning and Reclamation

Oil or gas well abandonment includes isolating and sealing off porous zones with cement plugs, cutting well casings one metre below ground level and sealing the well with a steel plate welded on top. Debris is removed and land restored to as near original condition as possible.

Abandoning a battery or compressor site includes removing equipment and debris. The land is re-contoured, dykes levelled, gravel and clay removed, and topsoil replaced to as near original condition as possible. Reclamation of the soil is currently the main thrust behind the proposed amendments to The Surface Rights Acquisition and Compensation Act.

FOCUS ISSUE 7:

The Great Sand Hills Land Use Strategy

Natural gas fields extend into the Great Sand Hills in southwestern Saskatchewan. Nearby gas development has generated considerable public debate. In July, 1990, the government placed a moratorium on all area development to protect the area's sensitive ecology while a land use strategy was developed. A planning committee held consultation meetings with stakeholders and the public to draft a land use strategy. The strategy was to consider existing and potential land uses, determine compatible land uses and provide direction for future land use. The final Great Sand Hills Land Use Strategy should be released in mid 1991.

POTASH

Potash, which is found about one thousand meters below the surface, has been mined in Saskatchewan for 38 years. Ten potash mines are currently in operation (Figure 34). Of these, 2 (Belle Plaine, Saskatoon area) are *solution mines*, which flood potash beds with undersaturated brine; the others are conventional *shaft mines*, which are dry-mined with horizontal boring machines.

Only about 35% of the material mined is potash.[28] In the mill, sodium chloride and insoluble clays are separated and deposited in tailings management areas. Tailings remain in the management area, while brine is recovered for mill reuse. Excess brine is injected into deep underground formations containing similar natural brine.

In 1989, potash mining produced and stored above ground some 18 million tonnes of tailings, bringing the total land stored tailings to approximately 300 million tonnes. The tailings occupy about 700 hectares of land. Potash mining occupies 3.4 thousand hectares of surface area; the underground mined area is 38.8 thousand hectares.

Brine Seepage

Tailings management areas are not impermeable. Without controls, brine could contaminate groundwater supplies, surrounding land and local water bodies. The industry currently feels able to contain or recover any brine seepage that may occur. Brine containment, recovery and monitoring systems are very large and complex. It will be several years before required monitoring can confirm or deny the industry's position.

Decommissioning and Reclamation

Although no potash mines will likely be decommissioned in the near future, today's operating practices will impact the mines' eventual decommissioning. Modifying current practices could permit reclamation of tailings management areas while the mines are still operational.

All potash companies in Saskatchewan were to develop preliminary mine site decommissioning plans for early 1990 submission. The industry studied tailings disposal alternatives while developing their decommissioning proposals. Methods studied included backfilling mined out areas with tailings, increased brine injection, modified solution mining and stabilizing surface salt.

Air Emissions

Potash processing emissions can include natural gas burning byproducts (greenhouse gases), and *particulates* (small particles). Regulations under The Clean Air Act limit the maximum permissible concentration of air emission particulates to 0.57 gm/m^3. At this level, degradation of the surrounding environment is not expected, though local residents still complain of accelerated rusting and localized tree damage. Further air emission evaluation is being considered. In 1989, out of 22 stacks tested at 10 potash mines, none exceeded air emission guidelines.

Spills

Brine is the most common spill at potash mines. Salt spills greater than one thousand kilograms must be reported. None were reported in 1989.

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28 Potash compounds are compared on the basis of their potassium oxide (K_2O) equivalent, a standard potassium content measurement. After refining potash ore, the finished product usually contains a minimum 95% potassium chloride (KCl), equivalent to 60% K_2O.

COAL

Saskatchewan has had coal mines since before 1900. Originally taken from shallow underground mines excavated into hill sides, coal is now extracted from five strip mines between Beinfait and Coronach (Figure 34). No underground coal mines are in operation. Of the coal produced, 80% is used locally for power generation, while 20% is exported.

Coal lies in horizontal seams up to 4 meters in thickness, under up to 40 meters of *overburden* (spoil). Topsoil is removed and stockpiled for future use, while huge draglines strip the overburden. When the coal is removed, the area is covered with spoil from the next pass of the dragline.

In 1989, 317 hectares of land were strip mined for coal; 269 hectares were reclaimed. A total of 9.4 thousand hectares have been mined for coal; 3.9 thousand hectares have been reclaimed.

Land Reclamation

Reclamation of strip mined land occurs after mining, and conforms with the government guidelines. Land occupied by levelled spoil piles roughly equals the area mined. Spreading topsoil and seeding is normally done within two years of mining.

Previously Strip Mined, Unreclaimed Areas

Near Estevan, some old spoil piles have been reclaimed, but most remain untouched. Almost all unreclaimed spoil piles lie over unmined coal deposits included in current operators' reserves. Almost all these previously worked areas will eventually be re-mined and re-contoured. However, some unreclaimed areas have become wildlife habitat that future reclamation may disturb.

Spills

The coal industry uses no chemicals considered environmentally hazardous. However, like any industry, petroleum product spills may occur. None were reported in 1989.

URANIUM

Uranium mining in Saskatchewan began in 1953. The original Lake Athabasca region mines have closed, but 3 currently operate in the Athabascan Sandstone region (Figure 34). Three more are in advanced planning stages. Some unmined high grade reserves average 14% uranium content, but most ore mined includes only 0.8% to 4% uranium content.

Uranium mining uses both open pit and underground mining techniques. Mills remove uranium, producing uranium oxide (U_3O_8) commonly called *yellowcake*. Mill tailings are deposited in a tailings management area. In this area, tailings dams contain the solids (one mine uses a specially adapted mined out pit), while liquids are treated, then recycled or released.

In 1989, uranium operations produced 717 thousand tonnes of tailings, bringing the total surface-stored tailings to 9.11 million tonnes. Tailings occupy about 160 hectares of land, while about 8.0 thousand hectares are leased to uranium mine operators.[29]

29 The surface leased area is not totally disturbed by mining operations. In a typical underground mine, approximately one-third of the surface area leased by the mining company would be used for tailings, infrastructure, etc. The remainder would stay in its natural state.

Tailings Management Problems at Cameco-Key Lake

The tailings management facility at Cameco-Key Lake is filling faster than predicted, demonstrating insufficient capacity for the tailings from the operation. Cameco was asked to review the problem, report on long term implications for decommissioning, and identify tailings disposal alternatives. The government also began an independent review.

In-Pit Tailings Disposal Modifications - Cameco-Rabbit Lake

Cameco's original operational proposal called for depositing solid tailings into the approved tailings disposal facility. Trials over 3 years have established that slurry placement would be more cost-effective. Citing detailed studies, Cameco claimed the operational change would not affect their final decommissioning plan.

Spills

During 1989, uranium mines had 21 *reportable*[30] spills, 16 of which were tailings, process material or mine water. Another 3 were petroleum products and 2 were other toxic chemicals including sulphuric acid and sodium chlorate. While 3 spills were largely unrecoverable, the rest were contained and cleaned up according to environmental regulations.

Reclamation and Decommissioning

Saskatchewan's uranium mining industry has had 6 mills, about 30 small high grade mine sites, and 25 that produced significant ore quantities. Of those 25, 19 have been decommissioned or are in the process. The Beaverlodge mill and tailings area has been fully decommissioned, with post decommissioning monitoring underway.

The present owner cleaned up the Lorado mill site in 1990, but the tailings area remains unreclaimed. The Gunnar mill and tailings areas have not been decommissioned. The original operators abandoned both Lorado and Gunnar mines in the 1960s. As a result, government must undertake any reclamation at these sites. Reclamation options have been studied, but necessary action must still be determined.

Beaverlodge decommissioning was completed in 1985, but remedial work was required to strengthen rock control structures on the Fookes Lake drainage system. Routine monitoring in 1989 indicated a stabilizing trend, especially on the Ace Creek drainage system. With completion of the initial 5 year monitoring term in 1990, a request to relinquish part of the decommissioning lease was anticipated.

The other three mills (Cluff Lake, Key Lake and Rabbit Lake), are operational, with feedstock derived from the three operating mines (Cluff Lake, Key Lake, and "B" Zone pit at Rabbit Lake).

Waste Rock Disposal

Waste rock disposal is part of the decommissioning and reclamation process. Data and sampling from 1989 indicate that some uranium mine wastes could leach contaminants (arsenic, nickel and radium 226) into runoff water. This information has implications for decommissioning and reclamation. However, standard procedures for investigating waste rock's leaching potential have yet to be established. Work to resolve this problem began in 1989.

Pipeline Spill Control

Spill control procedures at all uranium production and test mines came under comprehensive review following the November, 1989 mine water spill at Rabbit Lake. Mine operators were asked to review their spill prevention, detection and containment procedures, and upgrade as necessary. Pipeline surveillance has been increased in the interim.

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30 The Environmental Spill Control Regulations of The Environmental Management and Protection Act specify the maximum quantity of each substance that may be emitted without reporting. Spills or emissions larger than this amount are termed *reportable*, and must be reported.

GOLD

Saskatchewan gold mining dates back to 1935, when a *cyanidation* mill (referring to dissolving gold with cyanide) was built at Goldfields (since abandoned) on Lake Athabasca to process ore from the Box Mine. Substantial gold mining did not resume until the early 1980s. Saskatchewan has two operational gold mines, Jolu and Jasper, north of La Ronge, and the depleted Star Lake mine (Figure 34). Saskatchewan is still largely under-explored for gold.

Saskatchewan has high grade gold ore, producing about 12.5 to 18.7 grams per tonne of ore from underground mines as deep as 260 meters. Milling pulverizes the ore and dissolves the gold in cyanide. Remaining material goes to the tailings management area, typically a modified small lake with low or no fish potential. Dams around the lake contain the solids. Under stringent controls required by Mineral Industry Pollution Prevention Control Regulations of The Environmental Management and Protection Act, heavy metals and cyanide are removed from liquids before their release to surrounding waters during open water season.

In 1989, gold operations produced 217 thousand tonnes of tailings and 145 thousand cubic metres of industrial effluent discharges, none exceeding licence limits. About 484 thousand tonnes of tailings occupy 45 hectares on surface, while about 4 thousand hectares are under gold mining leases.[31]

Wetland Treatment for Copper in Effluent

Copper, a gold mining byproduct, remains in the liquid effluent. In high concentrations, it has potential to negatively affect the environment. Both operating mines have had difficulty meeting pollution control regulations on copper removal. Until the end of 1989, the only proven process has been sprinkling effluent on wetlands, where plant roots and peaty soils absorb the copper. Water sampled downstream of the wetlands shows copper concentrations well below effluent quality limits, and is suitable for discharge into the environment.

Other jurisdictions have successfully demonstrated wetland treatment for copper reduction, alone or combined with other processes. Wetland treatment is considered experimental until more study demonstrates its long term viability and decommissioning value.

Decommissioning and Reclamation

Star Lake Mine's Rush Zone was the first fully decommissioned and reclaimed gold mine under The Environmental Management and Protection Act. Mine openings were permanently sealed, land stabilized, and surface facilities removed to ensure safe human and wildlife access.

The Vista Mines Boot Leg Lake gold mine near Creighton closed in 1989. Unless further mining or milling are proposed, decommissioning and reclamation are required there.

Water Recycling

Both operating gold mines improved industrial water recycling to reduce volumes discharged to the environment. Star Lake was recycling more than 80% at the time of its closure, and Jolu was recycling about 95% by the end of 1990. Recycling has proven environmentally and economically sound, because of reduced chemical use in milling. Recycled water containing up to 50 mg/L of cyanide could reduce cyanide use by 10%.

Spills

Gold mining had 3 reportable spills in 1989. All were petroleum; all were contained and mostly recovered.

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31 Like uranium mining, much of this surface leased area remains undisturbed during underground mining operations.

FOCUS ISSUE 8:

Abandoned Mines

Hundreds of small mines in Saskatchewan were abandoned when the ore ran out or became uneconomic to recover. They were never properly decommissioned or reclaimed, having been abandoned before regulatory controls existed. About 550 mines (Table 18), abandoned before regulations were established in 1980 have been evaluated. Despite large numbers, most mines are very small, and very few need corrective action. All mines existing or established after 1980 must complete an approved decommission and reclamation program before abandonment. The process includes post reclamation monitoring to ensure successful compliance with regulations.

Environmental and Safety Hazards

Abandoned underground coal mines may contain lethal or explosive concentrations of hydrogen sulphide and carbon monoxide. Underground workings can be unstable and subject to collapse, causing unstable ground surfaces. Because of surface instability, surrounding land commonly becomes unproductive and the landscape's appearance deteriorates.

Abandoned uranium and gold mines often contain deep vertical or steeply inclined, poorly marked open shafts. Tunnels could have loose rock fragments falling from ceilings. Some uranium mine sites may contain radioactive tailings that could release radionuclides into adjacent water bodies.

Abandoned gold mine sites may contain tailings rich in sulphide-bearing minerals that can oxidize into sulphuric acid. Cyanide from the milling process could also be present.

In 1988, government established The Abandoned Mines program to identify abandoned mines, assess human and environmental hazards, and take corrective action.

Table 18:
Number of Abandoned Mines, 1989

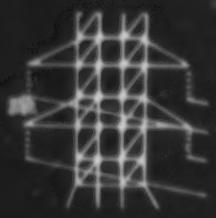
Coal	405
Uranium	55
Gold	80
Other (Base Metals)	7
Totals	547
Mines for which corrective action may be required	30
Mines with corrective action taken in 1989	15

Corrective Action

Remedial action at abandoned coal mines primarily involves filling surface holes caused when underground tunnels collapsed. Work at other mines includes capping or fencing open shafts and surface openings.

DOWN THE ROAD...

- Collect data on the treatment and disposal of oily waste
- Evaluate the success of decommissioning and reclamation activities for oil, gas and mining operations
- Collect data on brine seepage rates from potash mines



NERATION

IN THIS SECTION...

- Business and industry use two-thirds, farm and residential customers one-third of electrical power generated in Saskatchewan
- About 70% of Saskatchewan's electricity is generated by burning fossil fuels
- Shand Power Station (1992) will be Canada's first coal fired plant designed to meet federal guidelines
- Some incinerator ash is used in road construction
- Hydroelectric developments control water levels affecting aquatic life in reservoirs
- Soil sterilants for vegetation control along transmission lines are all but eliminated
- Lower power consumption can reduce environmental impact due to lower future power generation

SaskPower, a Crown-owned electrical utility, serves over 400 thousand customers, including residential, farm, commercial, industrial and corporate users (Table 19). Its rated generating capacity is 2,753 megawatts (MW) from 14 power stations, delivered through 140 thousand kilometres of transmission and distribution lines.

During years of average water supply for hydro generation, 70% of the electricity is generated by burning coal, 25% from water, 3% from natural gas peaking stations and 2% is imported from utilities in Alberta, Manitoba and North Dakota (Table 20).

Table 19:
Power Sales by Customer Class, 1989[32]

Category	Megawatt Hours (000)	Percent
Residential	2.2	19.2
Farm	1.5	12.6
Commercial	3.0	25.3
Industrial	3.9	33.1
Bulk and Corp. Use	1.1	9.8
Totals	11.7	100.00

Table 20:
Power Generation, 1989

	Megawatt Hours (000)	Percent
Coal	9.8	73.6
Hydro	2.8	21.3
Gas	0.5	3.7
Oil	<0.1	<0.1
Interchange	0.2	1.4
Totals	13.3	100.00

COAL FIRED GENERATION

Burning non-renewable fossil fuels (coal and natural gas) depletes their supply, and can also contribute to acid precipitation and global warming. While technological solutions have reduced or eliminated emissions causing acid precipitation, no practical solution exists to reduce carbon dioxide emissions which are primarily linked to global warming.

ACID PRECIPITATION

Acid precipitation occurs when sulphur and nitrogen oxides in the atmosphere combine with water vapour to form acid, which returns to earth in precipitation. Acid precipitation has degraded forests and acidified lakes, primarily in eastern Canada.

32 Excludes export sales of 147 thousand megawatt hours.

GLOBAL WARMING

Global warming may potentially occur as a result of increased concentrations of *radiative* (greenhouse) gases in the atmosphere. Human activity has increased concentrations of these atmospheric gases. Some predict that global temperatures could rise several degrees Celsius by the year 2050. That increase could alter major ecosystems and cause weather pattern changes.

The major radiative gases are carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrogen oxides. Most of these occur naturally with a small portion originating from human activity. Fossil fuel burning annually adds an estimated 5.5 billion tonnes of carbon dioxide to the atmosphere. Natural processes reabsorb only about 3 billion tonnes, leaving a net build up of 2 to 3 billion tonnes per year.

Globally, Canada contributes about 2% of man-made radiative gas emissions. The industrial and transportation sectors contribute about one-third each and electric power generation, less than one-quarter. Saskatchewan, with 4% of the Canadian population, contributes 7% of Canada's carbon dioxide. Table 21 illustrates energy consumption and carbon dioxide produced by various sectors.

Table 21: Fossil Fuel Burning in Saskatchewan, 1988[53]

Sectors	Energy Consumed (Peta Joules)[54]	Carbon Dioxide Produced/ Capita (000 tonnes)
Energy Producers	51	4,070
Industry	64	6,410
Transportation	53	3,650
Agriculture	44	4,150
Consumers	96	7,930
Commercial and Institutional	46	5,390
Total	354	31,600

AIR EMISSIONS

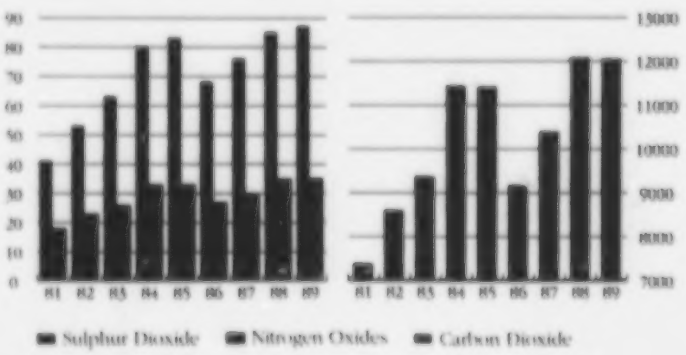
Figure 35 shows gas emission rates from power plants between 1981 to 1989. The figures are based on how much generation came from coal and natural gas, and on the fuels' emission factors.

Sulphur dioxide emission levels are low when compared to other Canadian and U.S. coal fired stations. This is due to the low sulphur content of western Canadian coals (0.6 to 0.8%) as compared to eastern coals (2.0 to 6.0%). Alkalis also help reduce sulphur dioxide production during burning.

Radiative Gases

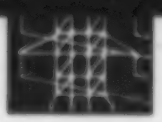
Some efforts are being made to reduce gas emissions from power generating stations. At the Shand Power Station, carbon dioxide will be diverted to a greenhouse to stimulate seedling growth rates; powdered limestone will be used to capture sulphur dioxide in a two phase absorption process (a Finnish technology); low nitrogen oxide burners will be used which have longer combustion periods reducing nitrogen oxide emissions. Shand will be the first plant in the country designed to meet federal air emission guidelines.

Figure 35: Carbon Dioxide, Sulphur Dioxide and Nitrogen Oxide Emissions, 1981-1989, (000 tonnes)



53 CO_2 Production and Global Warming. Saskatchewan Trends Monitor. 1989. Volume 6, Number 7.

54 One Peta-Joule = 10^{15} Joules.



Particulates

Between 30 and 35 thousand tonnes of particulate matter (*flyash*), which is released in the burning process, is recovered annually from the Boundary Dam Power Station. Electrostatic precipitators installed at some power plants (Boundary Dam Unit Number 6, Poplar River Units 1 and 2, Shand Unit 1) will remove more than 99% of flyash from emissions.

Flyash has been used in practical applications in Estevan, such as the airport runway base, highway weigh station and the Estevan brick plant. Poplar River Power Station stores ash in open lagoons lined with impervious material to prevent leaching into local aquifers. Lagoons at Boundary Dam and Estevan generating stations use indigenous clays to prevent leaching. A recent study at Boundary Dam indicated very low lagoon leakage, which soil constituents neutralize. At Shand, ash will be dry hauled to a disposal site to conserve available water.

WATER QUALITY

Several years of below average runoff to the Boundary Dam Reservoir have contributed to increased boron levels. To improve water quality, wells drilled into the Estevan Valley and Tableland aquifers now supplement reservoir water. As well, new facilities redirect ash lagoon decant water back to the station rather than the reservoir. This closed loop system is similar to that at the Poplar River station. Shand will also operate with a closed loop system, with evaporation the only discharge into the environment.

HYDRO GENERATION

Hydroelectric station reservoirs could affect the environment by eliminating farm land, altering wildlife habitat, blocking natural fish migration and altering natural water levels. However, reservoirs can provide water for irrigation, new wildlife habitat and recreational opportunities, and can protect downstream communities from flooding.

Fish Rearing

Mitigative measures for the Nipawin Hydroelectric Station included building fish rearing ponds near Melfort. Pickerel fingerlings raised in the ponds enhance fish populations in the area. Efforts are also made at the Tobin Lake Reservoir (E.B. Campbell Hydroelectric Station) to ensure that the water level drops less than 5 centimetres during the 30 day spawning season, enabling a successful fish hatch.

Reservoir Clearing

All trees and shrubs are cleared from new hydro reservoirs, ensuring a clean, safe water body for potential users.

TRANSMISSION AND DISTRIBUTION LINES

Transmission and distribution lines and substations require vegetation-free zones to prevent safety hazards and power outages from trees touching energized lines. In the past, soil sterilants have been used, but were found to wash off treated areas during heavy rainfalls shortly after spraying, and affect surrounding land. As a result, only non-persistent control chemicals have been used in the last two years.

Until a long term right-of-way maintenance policy is established, soil sterilants will not be used for tree and brush control. Hand clearing and machines are being used, and alternative weed control methods are being investigated. Chemical weed control for single phase rural lines will be eliminated as rural lines are rebuilt underground.

RURAL UNDERGROUND DISTRIBUTION

In 1983, SaskPower began a 20 year program to replace all 14.4 KV (single wire) rural lines with underground cable. Underground lines are expected to reduce power outages and the hazard of using farm machinery near electrical lines. By December, 1990, over 15 thousand kilometres of cable had been installed for over 10 thousand farms. Also, single farm taps served off a main 3-phase overhead 25 kV system that were to be rebuilt or extended, will be replaced. To the end of 1990, an additional 1,400 farm taps and 600 kilometres of cable have been buried.

Table 22:
Demand Side Management Programs

Capacity Interruption Contracts
Two large industrial and several irrigation customers on interruptible contracts represent a total potential load of 152 MW at time of system peak. As well, 10 MW of interruptible load is available during the summer.

Time-of-Use (TOU) Rates
TOU rates are designed to encourage large commercial and industrial customers to shift loads from daily peak to off peak periods.

Streetlight Conversion Program
Municipalities were encouraged to replace existing mercury vapour street lights with more efficient high pressure sodium vapour lights. Gross reduction of streetlight load from this recently completed program was about 6.5 MW.

Farm Light Conversion Program
Saskatchewan's approximately 100 thousand farm yard lights are mostly mercury vapour and incandescent. Customers are encouraged to convert to high pressure sodium vapour lights. The potential load reduction is about 5 MW.

PowerWise Program
The program provides information about electrical use, ground source heat pumps, appliance operating costs, electrical meter tabulation, demand meters, vehicle plug-ins, solar or wind powered pumping systems for livestock watering, energy efficient electric water heater cash rebate program and energy audits.

Energy Audits
In 1990, SaskPower conducted more than 100 energy audits, recommending cost saving measures to Saskatchewan industries and businesses.

Solar or Wind Powered Pumping Systems for Livestock Watering
SaskPower grants $500 towards purchasing a solar or wind powered water pumping system (for livestock watering) from a Saskatchewan supplier. The grant promotes an economically and environmentally preferred option to building a service extension for a livestock watering well's small electrical load.

DEMAND SIDE MANAGEMENT

Future electrical generation needs can be reduced by helping customers manage electric consumption. Reducing demand conserves fuel resources, reduces wastes and defers building new generating facilities. Street and farm light conversion, capacity interruption contracts, time-of-use rates and the PowerWise program all help customers manage electricity consumption (Table 22).

PCB STORAGE

In compliance with federal government regulations, PCB-filled capacitors and transformers are being replaced with non-PCB oil. A new PCB (polychlorinated biphenyl) storage facility near Boundary Dam will hold liquid and solid wastes and PCB-contaminated equipment for SaskPower and other Saskatchewan parties, pending suitable disposal means. Two smaller storage sites for PCB-filled transformers exist at Boundary Dam and at the Island Falls hydroelectric station in northern Saskatchewan.

DOWN THE ROAD...

- Provide data on the *pH* (acidity) of precipitation

URBAN ENV

IN THIS SECTION...

- Cities affect their surrounding environment in relation to their size, population density and growth rate
- In Saskatchewan, urban expansion can not avoid agricultural land consumption
- Waste generation and disposal is a common urban environment issue
- Many Saskatchewan communities recycle some solid wastes
- Noise is an environmental factor in some Saskatchewan cities

Urban populations affect many aspects of the environment. As cities expand, they consume agricultural land; cities produce liquid and solid wastes requiring disposal; and they attract industry and power plants with potential for emissions that could degrade air quality and contribute to the greenhouse effect.

The degree of impact varies with population size, urban density, growth rate and physical form. While Saskatchewan's cities are small compared to other Canadian centres, they still have an environmental impact. However, their population size, density and growth rate make the impact manageable.

Table 23: Urban Population Growth

	1976	1986	Percent Rate of Change 1976-86
Saskatchewan[55]	921,323	1,009,613	8.7
Rural	252,969	230,411	(8.9)
Urban[56]	626,095	734,940	17.1
Cities			
Regina	149,608	175,064	17.0
Saskatoon	133,793	177,641	32.8
Toronto	2,805,101	3,427,168	22.3
Calgary	469,917	671,326	42.9
Winnipeg	578,217	625,304	8.1

Table 24: Comparative Population and Population Densities, 1986[57]

Provinces	Land Area[58] km²	Population (000)	Density (Persons/km²)
Saskatchewan	570	1,009,613	1.8
Manitoba	548	1,063,016	1.9
Alberta	638	2,365,825	3.7
Cities			
Regina	110	175,064	1,590.6
Saskatoon	132	177,641	1,343.2
Toronto	97	612,289	6,302.5
Calgary	535	656,104	1,189.4

55 Saskatchewan population includes the census figures for the Northern Saskatchewan Administration District (NSAD).

56 Urban population includes census figures for all cities, towns, villages and resort villages, but does not include the NSAD or Indian Reserves.

57 Statistics Canada 1986.

58 Does not include water.

URBAN POPULATION IN SASKATCHEWAN

Saskatchewan's population is becoming more urbanized, with Saskatoon and Regina growing the fastest. Saskatchewan's population has grown faster than Manitoba's (Table 23).

Most of Saskatchewan's urban centres are located on or near prime agricultural lands.[39] Urban expansion, therefore, cannot avoid annexation of these lands. Between 1961 and 1981, urban centres annexed about 22.0 thousand hectares of agricultural land, and the process continues.[40]

PHYSICAL URBAN FORM

Saskatchewan's major urban centres are relatively compact compared to other major Canadian centres. In 1986, Regina and Saskatoon had 33.7% and 12.9% higher population densities than Calgary, Alberta, and 52.9% and 29.1% higher densities than Winnipeg, Manitoba respectively (Table 24).

In environmental terms, Regina and Saskatoon use urban land efficiently. Short distances for intra-urban travel means less fossil energy is used for internal transportation.

Table 25:
Estimates of Solid Waste Generated in Ten Saskatchewan Cities[41]

Cities	Total Tonnes/ Year (000)	Rank	Kilograms/ Capita/Day	Rank
Regina	266.0	1	2.2	5
Saskatoon	100.0	2	N/A	
Moose Jaw	55.0	3	2.7	2
Prince Albert	26.0	4	N/A	
Swift Current	14.9	7	2.6	4
Estevan	N/A[42]	-	-	-
Yorkton	15.6	6	2.7	3
Weyburn	N/A[43]	-	-	-
North Battleford	10.9	8	2.0	6
Lloydminster	20.7	5	5.4	1
Canada	N/A	-	2.3	-

SOLID WASTE MANAGEMENT

Solid waste generated in urban centres is becoming an environmental concern. Canadian metropolitan areas are finding fewer available waste disposal sites, and traditional landfill systems are posing air and water pollution risks.

Saskatchewan's 534 urban and 299 rural municipalities operate 783 municipal landfill facilities under the provincial Municipal Refuse Management Regulations. Approximately 50 facilities comply with the regulations. Open burning of refuse (now prohibited) is a common problem at small municipal garbage disposal sites. Open pit incinerators are being phased out. Regina and Saskatoon, Saskatchewan's largest urban centres, generate the most solid waste by weight (Table 25).

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39 Class 1, 2 and 3 agricultural capability lands according to the Canada Land Inventory data.

40 Report on Urban Land Annexation, Saskatchewan Urban Affairs, 1984. Most annexed land becomes part of a pool, and is developed for urban uses over time.

41 Data provided by various City Engineering Departments.

42 No weigh scales.

43 No weigh scales.

Table 26:
Quantity of Hazardous Waste Disposed of, by Management Technique, (1990)[44]

Management Technique	Solid Waste Tonnes/Year	Liquid Waste Litres/Year
Recycled	42.6	32.8
Reused (as is)	0.1	3.2
Landfill	13.2	1.3
Secure Landfill(a)	0	0.1
Burned	0	0.7
Sewage Treatment	<0.1	4.2
Long Term Storage(b)	2.9	0.5
Temporary Storage(c)	0.2	0.1
Neutralized(d)	0	56.8
Surface Land Application	0	5.2
Lagoon	0	3.0
Deep Well Injection	0	0.4
Fate of Waste Unknown	0.4	11.8
Total	59.4	120.1

(a) designed to safely accept deposit of hazardous wastes

(b) waste is stored for an extended time period, without further disposal options

(c) waste is stored pending removal to off site storage or disposal

(d) treated to counter corrosiveness and discharged into sewer system as normal waste

HAZARDOUS MATERIALS

Approximately 3,500 hazardous substance storage facilities are located throughout Saskatchewan. Of this total, 900 are agricultural warehouses, 1,500 are service stations, 400 are bulk plants and 500 are other storage facilities.

The Hazardous Substances Regulations

The Hazardous Substances Regulations, in effect since April, 1988, protect the environment and public from hazards of storing chemical substances. The regulations govern above and below ground tanks, warehouses and storage yards.

In 1990, 322 agricultural chemical storage facilities were inspected. Facility ratings varied from well managed, near conformance to poorly managed, unacceptable facilities.

Hazardous Waste Disposal

Approximately 59.4 thousand tonnes of solid and 120.1 million litres of liquid waste dangerous goods are produced and disposed of in Saskatchewan in a year. A variety of disposal techniques are utilized (Table 26).

Spills

Despite efforts to handle and transport hazardous substances safely, accidental spills do occur. If spill volumes exceed levels identified for various pollutants[44], in The Environmental Spill Control Regulations, they must be reported.

The Spill Report Centre monitors and responds to all reported spills. Spill numbers for 1981 to 1990 (Table 27) and volumes for 1990 spills (Table 28) are illustrated. All spills were cleaned up in compliance with regulations.

Household Hazardous Wastes

Collecting household hazardous waste is not yet done province-wide. In 1990, only Regina (59 drums), Moose Jaw (18 drums) and Maple Creek (2 drums) collected household chemicals for safe disposal.

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44 Pollutants identified in the regulations include agricultural chemicals, petroleum products, acids, heavy metals and other industrial chemicals.

45 Cochrane Lavalin Inc. 1991. Saskatchewan Waste Dangerous Goods Management Plan - Progress Report to Saskatchewan Environment and Public Safety. Regina, Saskatchewan.

Table 27: Number of Reportable Spills, 1981-1990

Spill Type	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Petroleum Related Spills										
Road Transport	38	23	20	41	51	34	35	25	30	30
Rail Transport	4	4	6	4	7	1	4	2	6	6
Service Stations	22	16	17	20	24	18	21	28	23	29
Bulk Plants	39	39	34	26	35	30	20	19	43	24
Refineries/Asphalt Plants	4	7	6	5	5	4	5	7	1	10
Storm Sewers	3	4	1	0	0	0	0	0	0	2
Transformers/Capacitors	6	4	2	2	25	5	1	0	1	6
General Spills	21	55	33	9	16	20	15	29	41	27
Non-Petroleum Related Spills										
PCBs	5	5	2	6	39	50	58	58	59	58
Acids or Bases	6	6	9	2	8	5	4	5	1	4
Biocides	18	17	24	12	17	10	9	7	9	9
Metals	0	2	0	0	3	0	0	0	0	0
Miscellaneous Inorganics	10	9	20	17	15	15	19	17	5	18
Miscellaneous Organics	5	7	12	0	1	2	1	0	0	8
Radioactive Materials	5	15	14	17	5	4	9	7	15	11
Waste Products (Sewage)	5	15	7	1	15	14	14	7	15	14
Various Industries	20	8	15	10	3	5	10	18	58	44
General Spills	15	10	1	1	0	5	2	8	15	0
Totals	222	222	221	175	245	212	207	257	280	280

Table 28: Reportable Spills and Quantity, 1990

Type of Spill	Number	Quantity (000 Litres)
Petroleum Related Spills		
Road Transport	30	158.7
Rail Transport	6	40.6
Service Stations	29	30.4
Bulk Plants	24	59.2
Refineries/Asphalt Plants	10	67.7
Storm Sewers	2	0.1
Transformers/Capacitors	6	4.4
General Spills	27	747.4
Non-Petroleum Spills		
PCBs	58	0.4
Acids or Bases	4	2.5
Biocides	9	4.8
Metals	0	0
Miscellaneous Inorganics	18	50.0
Miscellaneous Organics	8	14.5
Radioactive Materials	11	126.0
Waste Products (Sewage)	14	8,687.5
Various Industries	44	4,088.7
General Spills	0	0
Totals	280	14,052.8

WASTE RECYCLING

Waste Streams

Saskatchewan produces an estimated 700 to 850 thousand tonnes of municipal solid waste annually. This total does not include sludges or industrial non-hazardous process waste that might be disposed of in landfills. Saskatchewan monitors 8 recyclable waste streams[46] and collects data for the following.

Glass: Saskatchewan generates about 50 to 60 thousand tonnes of waste glass annually. About 1% is being collected for recycling.

Paper: Saskatchewan generates an estimated 250 to 300 thousand tonnes of waste paper each year. Approximately 4% is being collected for recycling. Close to 65% of this recycling takes place in Saskatchewan.

Plastic: Saskatchewan generates an estimated 55 to 77 thousand tonnes of plastic annually. Polyethylene terephthalate (PET) beverage bottle plastic, 1% of the plastic waste stream, is collected for recycling. No plastic is recycled in Saskatchewan.

Rubber: Approximately 800 thousand to 1 million tires are discarded each year in Saskatchewan. About 50 thousand are reused (retreaded) or recycled (as door mats).

Recycling Efforts

Some municipalities have begun collecting and recycling some wastes to reduce quantities for landfill disposal. Other municipalities are planning recycling programs.

Regina is planning a newspaper recycling program in 1991, has a household composting program underway, reclaims asphalt and recycles waste concrete and office paper waste. Regina is further studying the city's recycling potential since an estimated 19% of the city's solid waste contains recyclable materials.

Saskatoon annually recycles about 9 thousand tonnes of paper city-wide. Both Saskatoon and Regina recycle *white waste* (large electric appliances). Regina and Moose Jaw collect about 10 to 15 tonnes of clear glass for recycling each month at bins in shopping mall parking lots.

Swift Current and Lloydminster are starting household waste recycling programs (cost shared with government) in 1991. These pilot projects will document the feasibility of household recycling programs in Saskatchewan.

Other communities have recycling projects under way but not all are known to the government. Communities are not obligated to report their projects.

Collection of waste paper from some government offices began in 1989. The collection is expected to expand to all government offices.

The government publishes a recycling directory listing Saskatchewan recyclers. Since input to the listing is voluntary, some recyclers may be unidentified.

Some volunteer and non-profit agencies operate recycling programs. SARCAN (Saskatchewan Association of Rehabilitation Centres) operates a province-wide beverage bottle and aluminum can recycling program. SARCAN collects about 75% of the aluminium cans and 70% of plastic bottles sold in Saskatchewan.[47]

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46 *Recyclable waste streams* include animal products, clothing/textiles, ferrous metals, non-ferrous metals, glass, paper, plastic and rubber.

47 The Leader Post. October 5, 1990. Regina, Saskatchewan.

Figure 36: NEF Contours for Regina

Figure 37: NEF Contours for Saskatoon

NOISE

Noise affects urban environment quality. Major urban area noise pollution sources are aircraft and airport operations, road traffic, industries and workplace noise (mechanical equipment).

Research on noise exposure levels shows that Noise Exposure Forecasts (NEFs) of 30 or lower generate few complaints;* NEFs between 30 and 35 create a more vigorous response from residents; and, levels from 35 to 40 can generate public complaints ranging from group actions and appeals to legal action.

In Saskatchewan, air traffic and airport noise concerns only Regina and Saskatoon. Parts of six Regina residential neighbourhoods (Figure 36), and five in Saskatoon (Figure 37) intermittently experience annoying airport noise (30 to 40 NEF levels). Both cities are regulating new urban growth near their airports and plan new traffic noise studies to assess and respond to airport noise.

URBAN PARKS AND OPEN SPACES

Available parks and open spaces enhance the urban environment, providing outdoor recreation and relaxation space. Cities benefit most from park spaces with adequate size[69], quality, distribution and easy access. Table 29 illustrates park areas for various cities.

Table 29: Parks and Open Spaces for Ten Saskatchewan Cities (hectares)[70]

Centres	Parks	Open spaces	Total area	Park/ 1000 persons
Moose Jaw	226.6	63.5	290.2	8.3
Prince Albert	201.0	574.2	775.6	23.0
Regina[71]	788.0	537.4	1,325.5	7.6
Saskatoon	734.2	365.8	1,100.0	6.2
Swift Current	147.7	463.4	611.1	59.0
Estevan	94.7	N/A	N/A	9.5
Yorkton	70.0	180.1	250.1	16.1
Weyburn	81.4	58.5	139.9	13.8
North Battleford	53.8	12.5	66.3	4.5
Lloydminster	N/A	N/A	267.1	37.3

DOWN THE ROAD...

- Assess the effect of urban density and population on air quality and fossil fuel consumption
- Collect data on municipal waste quantities generated per capita
- Identify hazardous waste disposal techniques and quantities disposed of yearly

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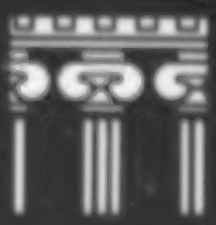
68 Transport Canada. 1981. Land Use in the Vicinity of Airports. Publication TP 1247E.

69 *Adequate size* means that parks meet the general standards of population to park space ratios at various levels (such as neighbourhood, community, municipal and regional levels).

70 Figures provided by City Parks and Recreation Departments.

71 City of Regina. 1988. Open Space Management Strategy Report. The Regina figures include the Wascana Park area of 405 hectares.



HERITAGE R

IN THIS SECTION...

- Regenerating and adapting Saskatchewan's heritage resources generates economic activity
- The Heritage Property Act regulates impact assessments and conservation requirements for heritage resources
- Acceptable substitutes are required before heritage resources are relinquished to other development
- Municipal governments, volunteer organizations and private enterprise are accepting partnership roles in conserving and managing heritage resources

Heritage resources provide information about the province's cultural and natural evolution. In Saskatchewan, these include various properties, sites, museums, historic parks, artifacts, art collections and archival documents.

ECONOMICS

Economic prosperity is linked with environmental protection and long term stewardship of cultural and natural heritage.

Since 1981, the provincial government's Heritage Grant Program has granted more than $2 million to 300 projects to restore public, private and commercial buildings, develop heritage tourism and conduct archaeological research. This assistance generated over $11 million in private sector investments, increasing employment, economic activity and tourism in both urban and rural communities.

Private investment has consistently exceeded government grant allocations. This indicates the growing gap between grant demand and grant allocation (Figure 58).

Historic resources refers to existing historic buildings and sites. *Archaeological sites* refers to sites and artifacts remaining from fur traders, early explorers and early Indian peoples. Findings of both these resources have been steady through the 1980s (Figure 59).

Figure 58:
Heritage Grant Performance, 1981-1988

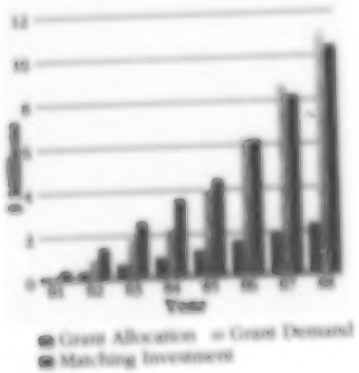
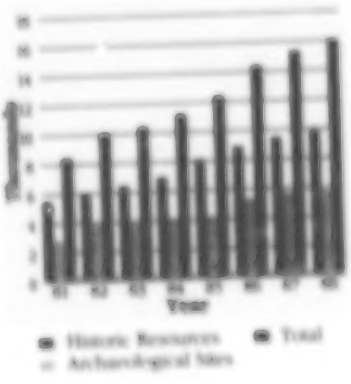


Figure 59:
Heritage Resources Recorded, 1981-1988



INVESTIGATIONS

Under The Heritage Property Act, private and public sector land development proposals are routinely reviewed to assess heritage resource impacts and identify conservation requirements. Since 1981, almost 350 investigation permits have been issued. Impact assessment and mitigation studies, including some large scale projects, have been important tools for archaeological resource management and research. This activity supports a small but vibrant heritage consulting industry.

ANALYSIS AND RECORDING

Land development, new construction and community growth typically accompany economic growth, and on occasion, threaten heritage resources' existence. However, some heritage resources can be adapted to new, economically viable uses. The costs and consequences of resource loss must be thoroughly understood and found acceptable before resource loss occurs. Both archaeological sites and historical buildings must be identified, and appropriate recording and protection determined.

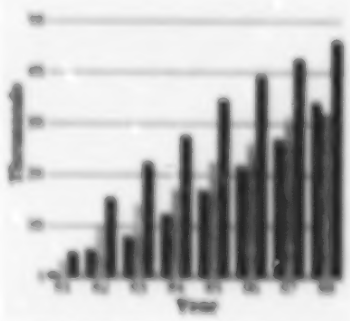
Compensation for resource loss may be required. For example, scientific excavation and analyses together with proper collection conservation and curation may acceptably substitute for losing some archaeological and *palaeontological sites* (containing fossil remains of vertebrate animals). 'As found' drawings, photogrammetric recordings, salvaged architectural elements, archival recording and research may similarly substitute for losing architectural resources to change or demolition.

RESOURCE MANAGEMENT

In Saskatchewan, municipal governments are participants in heritage resource affairs. Some municipalities are incorporating resource management policies and objectives into municipal development plans and zoning by-laws. The Heritage Property Act empowers municipalities to protect and restore historically significant structures.

There are almost 80 provincially designated properties and over 450 municipally designated heritage sites in more than 300 communities or municipal jurisdictions (Figure 40).

Figure 40:
Heritage Designations



Municipalities are partners in Saskatchewan's heritage. They co-fund community museums, maintain archival records and establish planning and conservation authorities. In addition to the 13 Municipal Heritage Advisory Committees established in urban centres, there are several municipally-based organizations focusing on urban community conservation issues.

VOLUNTARISM

Six provincial cultural organizations form the Heritage Saskatchewan Committee of the Saskatchewan Council of Cultural Organizations. The committee coordinates heritage activities of mutual interest to Saskatchewan's volunteer community.

The Museums Association of Saskatchewan
- offers training and advisory services to museums and provides guidelines for recognized standards of museum operation

The Saskatchewan Natural History Society
- fosters knowledge, appreciation and enjoyment of the natural world and promotes conservation of natural heritage resources

The Saskatchewan Archaeological Society
- promotes and encourages study, preservation and proper use of Saskatchewan's archaeological resources

The Saskatchewan Genealogical Society
- encourages study, research and preservation of genealogy and family history

The Saskatchewan History and Folklore Society, Inc.
- dedicated to preserving Saskatchewan's social history and folklore

The Saskatchewan Architectural Heritage Society
- focuses on conserving the heritage built environment

Opportunities for private sector involvement exist, especially for the construction, heritage consulting and hospitality industries. Some firms, especially in the design professions, are entering niches opened by heritage resource conservation and development activities.

Joint private and public sector initiatives are improving downtown business and residential districts by retaining and developing civic heritage assets.

DOWN THE ROAD...

- Evaluate heritage resource's role in sustainable development

THE L

A Steering Committee from twelve government agencies cooperated to design and prepare Saskatchewan's first State of the Environment (SOE) Report. Its use and evaluation is up to you, the readers.

This report's first pages alerted you to a format with minimum interpretation, permitting you to draw your own conclusions about its contents. If you found the information and format useful, the committee will have met some of its objectives.

Each section's **Down the Road** topics acknowledge subjects or activities the Steering Committee believed would improve future reports. Some are already being addressed by a task group under the Canadian Council of Ministers of the Environment (CCME).

The CCME task force is working to harmonize SOE report structures among provinces. It also encourages provinces to develop environmental indicators and use them consistently across the country. As these inconsistencies are resolved, readers will find SOE reports more understandable, and province-to-province comparisons more valid.

Recommendations from an independent advisory committee will help determine the direction for future SOE reports. However, readers may like to see other changes. If you have suggestions to improve the information and its presentation in this report, or ways to help evaluate it, we would like to hear those ideas. The next page invites your comments and evaluation.

Thank you for taking time to read and evaluate this first report, and for the comments you contribute.

Additional copies of this report are available from:

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Reader Comments:

Saskatchewan State of the Environment Report

Saskatchewan Environment and Public Safety invites reader reaction to this report. Your evaluation, comments and suggestions can help subsequent reports serve readers' needs better. Please take the time to complete this questionnaire, add your own suggestions on the reverse side, and mail it to the address shown.

Evaluation

Please circle the appropriate number to answer the question. On the scale, 0 represents no value, 1 is poor, and 5 indicates excellent.

1.	How well did the report help you identify established or emerging *environmental trends*?	0	1	2	3	4	5
2.	How well did the report help you identify potential *environmental problems or issues*?	0	1	2	3	4	5
3.	How well did the report help you compare the state of our province's environment with other places?	0	1	2	3	4	5
4.	Was report language clear and understandable?	0	1	2	3	4	5
5.	Did you get enough information to draw conclusions about the state of the environment?	0	1	2	3	4	5
6.	Does the report provide new or otherwise unavailable information?	0	1	2	3	4	5
7.	Will you get and use next year's State of the Environment Report?	Yes			No		

Comments

Please tell us what else you would like to see in subsequent State of the Environment reports.

How can we improve the report, or make it more useful to you? (for example, language, format, style)

Mail this completed questionnaire to:

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